12. Preliminary Environmental Impact Statement: Ponce Landfill Expansion, Geotechnical Services, Inc., 1978.

13. Report of Investigations on Co–disposal Area and Closure Activities associated with SK & F Surfacement Impondment area for CECOS International, Inc., by RCRA Research, Inc., May 1, 1984.

14. Personal Communication during Visual Site Inspection, conducted on July 17, 1986.

1.8 Attachments

1.8.1 Visual Site Inspection Summary

On July 17, 1986, Mr. Ken Hiltgen of Lee Wan and Associates (LWA) conducted a visual site inspection (VSI) of the Municipal Dumping Facility, Ponce, Puerto Rico. The visit began at approximately 10:30 AM with a meeting between Mr. Hiltgen and Mr. Rick Good of CECOS. The meeting lasted approximately 90 minutes, after which a walk-through inspection of the facility was conducted. The walk-through inspection lasted for approximately 90 minutes. The weather was clear throughout the entire site inspection.

1.8.2 Visual Site Inspection Field Notes

The following findings relative to site conditions and waste management practices were confirmed during the VSI through direct observation and/or discussions with facility personnel.

1. The old SK & F lagoons (SWMUs 1 and 2) have been filled. The exact locations of these lagoons could not be identified due to substantial landscaping alterations and landfill operational changes over the past few years.

2. The sanitary landfill (SWMU 3) is operated in stages ranging from 2 to 3 tiers. Fill cover over landfilled materials varies from a few inches to 50 feet or more with no visual means of determining its depth.

3. The drum and tank storage area, identified during the file review, was found to be non-existent. It was suspected that this drum and tank storage area might be a temporary unit at one time or a part of the planned future facilities at the site.

4. Industrial hazardous wastes were disposed at the existing landfill site and often placed between two layers of sanitary wastes with various thicknesses. It is highly improbable to determine the exact locations or depths of these landfilled hazardous wastes due to lack of records and major alterations of landscaping of the general area.

5. Law Engineering was contracted by CECOS to conduct an investigation of the co-disposal landfill area in 1983 through 1984 (see Reference 13). Eight soil borings (CA-1 through CA-8 as shown in Figure 4-6) were drilled at varying depths in areas suspected as potentially having received hazardous wastes or liquid wastes. Although hazardous constituents such as cyanide, barium, and PCB were detected among all or some composite samples, the exact location and/or depth of the disposed hazardous wastes were not located. In boring CA-2, a zone of very high explosive gas production (presumably methane) was encountered near the base of the fill material. A zone of wastes from a tuna packing plant was identified in boring CA-3 based on the unusual texture and odor of the material. Perched water conditions were encountered in the waste-fill in most of the borings.

6. Site roadways are constantly being changed and rerouted as landfill areas of operation change. Construction of site roadways required the excavation of waste fill material. As a part of Law Engineering/CECOS investigation in 1983-1984, soil samples were taken from the fill material and analyzed for hazardous constituents. The results indicate that none of the material sampled would be classified as hazardous wastes. (Reference 13)

7. The old stream bed identified from aerial photographs has been obliterated.

8. The area is severely faulted, resulting in a very complex hydrogeological system. This makes it difficult or impossible to determine what areas are being monitored by the existing monitoring wells and/or location of up-gradient or down-gradient wells.

Five photographs which document the condition as observed during the VSI on July 17, 1986 are provided in Appendix C.

1.8.3 SWMU Location Map

The location of the four SWMUs, relative to the site, is indicated on Figure 1-2 (page 8) of this report.

APPENDIX A

GROUNDWATER
MONITORING
DATA
(1983 – 1984)

Source: RCRA Part B permit application, Ponce Center for Environmental Control, Revised May, 1984. Section 4 – Groundwater Monitoring. (Reference 4)

TABLE 3

SPECIFICATIONS OF GRAIN-SIZE DISTRIBUTION FOR FILTER PACKS

SAND TYPE	U.S. STANDARD SIEVE SIZE	PERCENT FINER BY WEIGHT PASSING CORRESPONDING SIEVE
Fine-to-Medium Sand	No. 4	100
	No. 10	70-100
	No. 20	35-100
	No. 40	10-80
	No. 60	0-25
	No. 100	0-5
Medium-to-Coarse Sand	3/8"	100
	No. 4	100
	No. 10	20-100
	No. 20	0-80
	No. 40	0-20
	No. 60	0-5

Step 2 Plot $(H-h)/(H-H_o)$ in logarithmic scale versus t, time elapsed since the beginning of test.

Step 3 Draw a straight line through the data points plotted in Step 2.

Step 4 Read off the basic time lag T_o from the straight line drawn in Step 3. This is the time corresponds to the point at the line where the value of $(H-h)/(H-H_o)$ equals 0.37.

Step 5 Calculate the hydraulic conductivity K, in cm/sec, by the following equation:

$$K = \frac{r^2 \ln (L/R)}{2 L T_o}$$

where: r = inner radius of well, cm
R = outer radius of screened section of well, cm
L = length of screened section of well, cm
T_o = basic time lag determined in Step 4 above, sec.

6.3 Potentiometric Levels and Groundwater Flow

Potentiometric levels of the Ponce Formation will be evaluated using the water level data obtained during hydrogeologic investigation. Such levels will be used to construct a potentiometric contour map of ~~Ponce Formation~~ specified aquifer formations to evaluate lateral gradients, flow directions, and flow rates. In addition, vertical groundwater hydraulic gradients will be determined from this data.

6.2 Hydraulic Conductivity Testing

Rising head tests will be conducted in test monitoring wells to measure in-situ hydraulic conductivity of the geologic strata adjacent to the saturated screened interval. These rising head tests will be performed after well development. The test will be conducted by recording the recovery rate of the water in the well verses time until the formation approaches static conditions.

The major steps in conducting a rising head test are:

Step 1 Record the initial water level H in the well.

Step 2 Remove a quantity of water from the well.

Step 3 Measure and record the water level H_o in the well immediately after removing the water from the well.

Step 4 Measure and record the water level h in the well at regular time intervals. The time interval between successive measurements should not exceed 1 hour during the first 6 hours after removal of the well water.

Step 5 Terminate the test when the water level in the well has approached the static level measured in Step 1.

The Hvorslev method will be used to analyze data collected in the rising head test. The major steps in applying the Hvorslev method are described below:

Step 1 Calculate $(H-h)/(H-H_o)$ for each water level h measured during the test.

6.0 HYDROLOGIC FIELD MEASUREMENTS

6.1 Groundwater Level Measurements

Groundwater elevations will be measured periodically throughout the field investigation using an electric water level indicator. Upon completion of well installation and development, water levels will be measured in all the wells on the same day. For QA/QC purposes, a measurement loop will be completed. This will be done by measuring the depth to water in the initial well of the survey again at the end of the survey. The data will be recorded in a field book and later transferred to a computer data management system.

6.1.1 Survey Measuring Points

The location and elevation of all test monitoring wells installed during this program will be determined by a registered surveyor. The survey will be done to the following accuracy:

Location - within 1.0 feet
Elevation - within 0.01 feet

A measurement point will be marked on the top of the well casing to assure consistency in future groundwater elevation measurements.

The location of the recommended surface sampling point will be established to the following accuracy:

Location - within 1.0 feet
Elevation - within 0.1 feet

5.6 Field Inspection and Quality Assurance/Quality Control Procedures

A GAI representative will supervise drilling, well installation, well development, and equipment decontamination activities. Field activities will be documented at the site by a GAI geologist/engineer, while some field data will be documented on the following field forms:

- o Field Corehole Log (Figure C-1)
- o Basic Drill Hole Data Sheet (Figure C-2)
- o Monitoring Well Installation Log (Figure C-3)
- o Well Development Field Record (Figure C-4)
- o Sample Collection Form (Figure C-5)

Field records will be duplicated at the site and the originals transmitted to the Atlanta office at least every week. These forms will be included in the final report.

Representative well installation materials (i.e. sand, grout) will be sampled for each test monitoring well installation. These samples will be placed in a clean one quart jar with lid, sealing the lid, labeling the jar accordingly, and storing the sample at the site for future reference. Also a sample will be taken of the water from steam cleaning the drill rods, before the start of one borehole. The water sample will then be analyzed for the parameters listed in Appendix A. The sampling documentation and shipment is described in Section 7.5. A field blank of the municipal water used for steam cleaning will also be obtained and analyzed for the list of parameters in Appendix A. (See Table 4). The analytical procedures for the analyses are detailed in the quality assurance plan for the site (Golder Associats Inc., 1988c, Table 2).

- o Establish an effective hydraulic connection between the well bore and the formation; and
- o Stabilize the formation surrounding the screen.

Air lift combined with surge pressurization with nitrogen will be used in well development. Surge pressurization will induce reversal of flow, avoid particle bridging, and provide adequate formation and filter pack stabilization. An alternate form of well development may be used (e.g. bailing the wells using a Teflon or stainless steel bailer with polypropylene rope) if surge pressurization does not produce adequate water for well development. Well development will be conducted in accordance with the well development form, Figure C-4. This will continue until the well produces representative formation water, which shall be assumed when pH, conductivity and temperature readings are stable and the water has achieved a sustained degree of clarity. The turbidity of the water at the completion of well development, in nephelometric turbidity units (N.T.U.) will be measured and recorded to establish the baseline for future sampling events. A minimum of five volumes of water standing in the well, at static conditions, will be removed during development.

Initial groundwater levels will be meausred prior to and after each well has been completely developed. Steady state conditions will be confirmed by taking water level readings subsequent to well development. The groundwater should be allowed to stabilize for a minimum of 24 hours after well development before additional readings are made. The period may be extended for low-yield wells where the water level will require a longer period to recover to its original position. A recovery or variable head test (refer to Section 6.2 for procedures) may be performed immediately after well development.

consist of fine-to-medium sand. For the #6 slot screen, the filter pack will consist of a fine-to-medium silica sand. The specifications for the grain size distribution of the filter pack are provided in Table 3. The filter pack will be installed using the tremie method while withdrawing the drill rods upward.

c) A saline resistant seal will be placed above the filter pack and will be extended to about 0.6 m (2 feet) below the ground surface. The seal material will consist of Volclay Grout or equivalent material. Appendix E contains the technical information and specifications for Volclay Grout. A mud balance test will be conducted for each batch of mix prior to placement. The grout slurry weight will be a minimum of 9.4 pounds per gallon at the time of placement. In application, the grout will be prepared by mixing with fresh water and installed by the tremie method. The drill rods will be pulled from the borehole subsequent to grouting.

d) Cement will be placed from 0.6 m (2 feet) to the ground surface. A protective surface casing with locking cap will be positioned over the test monitoring well and cemented in place. A 6 mm (0.25 inch) diameter vent hole will be placed in the end cap. Three 6 mm (0.25 inch) diameter drain holes will be placed in the protective surface casing directly above the cement seal to drain all the water that may be accumulated in the annular space during well development and sampling.

The filter pack design described above is applicable to the expected water table aquifer conditions. If confined conditions are encountered, such that the well may collect water from more than one aquifer, the design will be re-evaluated.

5.5 Test Monitoring Well Development Procedures

The completed test monitoring wells will be developed to:

- Remove any fluids introduced into the well;

field parameter measurements of pH, specific conductance, and temperature will be taken. Refer to Section 7.4 for field parameter measurement procedures.

5.4 Test Monitoring Well Installation Procedures

The installation procedures for the recommended test monitoring wells will be consistent with installation procedures for RCRA groundwater monitoring wells, as outlined in the U.S. EPA Technical Enforcement Guidance Document, 1986. (United States Environmental Protection Agency, 1986.) A test monitoring well may therefore be used as a groundwater monitoring well upon the completion of the hydrogeologic evaluation. Figure 7 depicts a typical installation diagram for the test monitoring wells.

Installation and completion of the test monitoring wells will be performed in the following manner:

a) Place about 150 mm (6 inches) of medium-to-coarse silica sand through the drill rods to the bottom of the hole. Construct a well while installing the well through the drill rod opening to the base of the borehole. The well will consist of a 6 m (20 foot), 50 mm (2-inch) diameter, stainless steel screen (#10 slot in consolidated rock formations and #6 slot in fine grained soils), a 3 m (10 foot) stainless steel well casing section (50 mm (2 inch)) above the screen, the appropriate length of 50 mm (2 inch) diameter flush threaded PVC well casing, and end caps placed on the top and bottom of the well. The screen will be installed such that the top portion of the screen transects the formation water table. Typically, the top of the screen will be located about 0.6 m to 1.5 m (2 feet to 5 feet) above the water level. A 1 m (3 foot) stick up will generally be established. All casing joints will be sealed with teflon tape.

b) Place a filter pack around and above the screened interval to about 1.5 m (5 feet) above the top of the screened interval. The filter pack for the #10 slot screen will consist of a medium-to-coarse silica sand, with the upper 1.5 m (5 feet) to

4). The analytical results of the drill cuttings soil samples and Ponce Formation background soil samples, obtained during the soil investigations at the site (Golder Associates Inc., 1988d and 1988e) will be compared. An evaluation will be made by comparing the constituents reported from the background samples to the constituents reported, if any, from the drill cuttings soil samples. Constituents reported in the drill cuttings soil samples that are also present in background soils, at a similar concentration, will be considered indicative of natural background conditions. Based on this evaluation, if the drill cuttings are considered non-hazardous they will be disposed in the site's landfill; otherwise, an alternative disposal facility will be used (to be identified at that time). The analytical procedures for the analyses are detailed in the quality assurance plan for the site (Golder Associates Inc., 1988c, Table 2).

The rock core obtained during drilling will be logged by a qualified GAI representative. A log form, included as Figure C-1, will be completed for each borehole. This form includes the depth and description of saturated zones and the total borehole depth. If any of the boreholes are terminated at a depth different from the originally planned depth as shown in Table 1, then the reason for terminating the borehole will also be noted in the borehole log. In addition, the borehole log and the drill hole data sheet will contain detailed descriptions of unusual features that may have been observed in the borehole. The core will be placed in core boxes, labeled, photographed and stored on site.

During the drilling process, groundwater samples will be obtained from the drilling recirculation system every 3 m (10 feet) once the saturated zone is encountered. The groundwater sample will be collected in a clean container and standard

~~Based on the current understanding of the site geology, all wells except GW-5 will be installed in a consolidated rock formation. It is expected that well GW-5 will be installed in fine grained alluvial or residual soils at the mouth of the valley. The well screen and filter pack were designed (Section 5.4) based on the available geological information. During the drilling of the borehole for test monitoring well GW-5, grain size analysis will be made on samples retrieved within the depth range where the well screen will be installed to verify the design assumptions.~~

Standing fluid in the surface casing will be flushed by circulating potable water at the bottom of the surface casing until relatively clear return is achieved. Subsequent drilling, using a nominal 14 cm (5.5 inch) outside diameter bit will then proceed through the surface casing, while coring rock to the desired depth. Upon reaching the desired depth, the borehole will be thoroughly flushed clean of any drill cuttings, and well installation will commence.

Deviation studies will be made on all the boreholes drilled. If significant deviations from the vertical exist, the water level elevation readings will be corrected to account for the deviation.

Drill cuttings recovered during the drilling operation will be stored in containers next to the borehole. Immediately following drilling activities for every two boreholes, a soil sample of the drill cuttings will be taken and analyzed for the Priority Pollutant parameters listed in Appendix A (excluding the the Priority Pollutants pesticide parameters, while the analyses for the Priority Pollutant metals parameters will be for total metals), plus up to the first 40 peaks. One sample will be taken for every two boreholes, in which the drill cuttings will have been combined (see Table stratigraphy. The geophysical logging device will be lowered downhole through the well casing to conduct the survey. Typical drilling procedures to be used at the site are outlined below.

In areas where the borehole is located in the landfill, it is understood that BFIP will clear away any refuse and fill to expose visibly clean natural material. The extent of any visible staining on the exposed soil surface will be noted in the drill hole data sheet (Figure C-2) and reported. This area will then be backfilled with clean borrow material. Surface casing will be installed in these boreholes to a minimum depth of 1 m (3 feet) into the natural material as a precautionary measure to minimize the potential of dragdown. Surface casing will not be installed for borings located off the landfill.

Borings will generally begin by drilling a nominal 23 cm (9-inch) diameter borehole 4.5 m to 7.6 m (15 to 25 feet) below ground surface, or a minimum of 1 m (3 feet) into the natural material. Upon reaching termination depth, the drill rods will be removed and 15 cm to 20 cm (6 inch to 8 inch) diameter flush threaded PVC casing will be placed in the open borehole. Approximately 15 cm (6 inches) of the surface casing will extend above the ground surface. The annulus between the surface casing and the borehole will then be grouted in place to ground surface by the tremie method. The grout mix should consist of 28.5 l (7.5 gallons) of potable water to one 42 Kg (94 pound) bag of Class A neat cement, with 5% bentonite powder. The mix proportion may be modified to accommodate field conditions. The grout will be allowed to cure for a minimum of 12 hours. The drill rig and drill tools will be steam cleaned before subsequent drilling in accordance with the procedures described in Appendix B.

The rinsate sample analytical results will be compared to the statistically significant detection limits (SSDLs) developed for the evaluation of the groundwater monitoring data. If the sample results are not considered statistically significant, the sump liner and the topsoil and polyethylene sheet within the decontamination pad will be disposed in the site's landfill. If the sample results are considered statistically significant, the sump liner may be disposed in another facility, to be identifed at that time. Furthermore, if the sample results show a statistically significant detection, at least one soil sample will be taken from beneath the sump and one from beneath decontamination pad. The soil samples will be analyzed for the Priority Pollutant parameters listed in Appendix A (excluding the Priority Pollutant pesticide parameters, while the analyses for the Priority Pollutant metal parameters will be for total metals), plus up to the first 40 peaks. The analytical procedure for the soil analyses are detailed in the quality assurance plan for the site (Golder Associates Inc., 1988c, Table 2). If the analytical results of the soil samples indicate that the soil represents an insignificant threat to human health or the environment the topsoil and polyethylene sheet within the decontamination pad will be disposed in the site's landfill; otherwise, the materials will be disposed in another facility (to be identified at that time).

5.3 Drilling Procedures

Boreholes in which test monitoring wells will be installed will be drilled using air rotary drilling techniques. The air will be filtered to remove oil from the compressor. Continuous formation rock core samples will be obtained during the drilling operation. If core recovery is inadequate to define the Ponce stratigraphy, then downhole geophysics (e.g. natural gamma) may be utilized to better define the formation rinsate water drains to a lined sump. A layer of 6 mil polyethylene sheet will be placed on the ground, completely covering the pad, and a 15 cm (6 inch) thick soil layer will be placed on the top of the polyethylene sheet.

The sump will typically occupy a 1 m (3 ft.) by 1 m (3 ft.) area to approximately 0.5 m (1.5 ft.) in depth. It will be lined with 6 mil polyethylene flexible membrane liner (FML) to maximize its liquid retention capacity. The liquid collected will be pumped daily to a tank truck such that there will be minimal standing water in the sump. The tank truck will be hauled to a wastewater treatment plant for disposal at regular intervals by BFIP. The name of the company selected to haul the rinsate water will be submitted to the EPA within 10 days from the date of this selection. The rinsate water will be disposed at a local publicly owned treatment works (POTW) facility in the vicinity of Ponce, Puerto Rico. The name and street address of the local POTW facility will be submitted to the EPA no less than 10 days prior to hauling the water.

On completion of the project, a rinsate sample will be taken from the sump liner. The sample will be analyzed for Priority Pollutants parameters listed in Appendix A (excluding the Priority Pollutant pesticide parameters, while the analyses for the Priority Pollutant metal parameters will be for total metals), plus up to the first 40 peaks. Table 4 lists the type of samples to be taken by matrix. The analytical procedures for the analyses are detailed in the quality assurance plan for the site (Golder Associates Inc., 1988c, Table 2).

5.0 ~~PROPOSED~~ WELL INSTALLATION PROCEDURES

5.1 General

The recommended test monitoring wells for the Ponce Municipal Landfill Facility will be designed and installed based on the stratigraphy and depth to water encountered at each monitoring location. The well screen slot size will be selected to provide sufficient hydraulic communication between the stratigraphic interval screened and to prevent the migration of fine grained sediment into the well.

The drilling procedures will be conducted to minimize the potential of dragdown of surface materials, to minimize the potential communication of surface or near surface water into the well while drilling, and to minimize potential cross contamination between wells from the drilling equipment. In addition, the well installation method will minimize the possibility of borehole collapse. The following sections present the procedures to be used to accomplish these goals.

5.2 Equipment Cleaning and Decontamination

The drill rig and drilling tools will be cleaned prior to initial use and between drilling locations. All well casings and other pertinent well materials will also be cleaned before installation. Cleaning procedures to be initiated are outlined in Appendix B.

A decontamination pad will be established on freshly exposed clean soil in the northwest portion of the site located off the landfill (Figure 4). Equipment cleaning will be performed at the decontamination pad rather than at each well location. Where necessary, small dikes will be constructed around the decontamination pad to prevent surface water from entering the pad and to confine the rinsate water within the pad. The surface of the pad will be leveled and graded so that all

ATTACHMENT IV-2

GROUNDWATER MONITORING WELL SPECIFICATIONS

* References and citations made to specific sections, tables, figures or other sources which are not included in this Attachment are available in BFI's revised Post-Closure Permit application, dated May, 1989 and is in the Administrative Record. The Administrative Record is located at U. S. Environmental Protection Agency, Region II, Permits Administration Branch, 26 Federal Plaza, New York, N.Y., 10278 and the Puerto Rico Environmental Quality Board, Santurce, Puerto Rico, 00910-1488.

MONITORING WELL INSTALLATION LOG

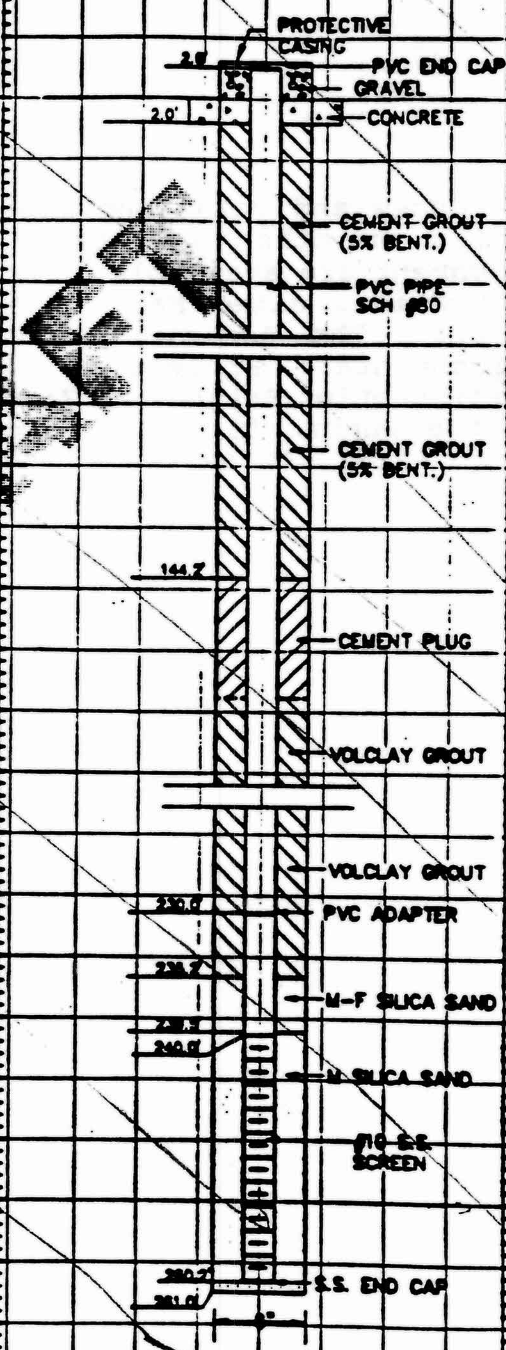
JOB NO. 893-[illegible]3.2 PROJECT BFI/RFA/PONCE WELL NO. GW-8 SHEET 1 of 1
GA INSP. RIO DRILLING METHOD CSR- CENTER SAMPLE ROTARY GROUND ELEV. [illegible] FT. ([illegible] M.) WATER DEPTH 240.42'
WEATHER PTLY CLOUDY DRILLING COMPANY DUAL TUBE DRILLING INC. COLLAR ELEV. [illegible] FT. ([illegible] M.) DATE/TIME 2/19/90 8:5
TEMP. 80's DRILL RIG AP 1000 DRILLER WESLEY JAMISON STARTED 10:30 2/19/90 (TIME / DATE) COMPLETED 2/20/90 12 (TIME / DATE)
LOCATION / COORDINATES 19,605.24 N (M.), 128,839.28 E (M.)

MATERIALS INVENTORY

WELL CASING 1 7/8" I.D. in. dia. 230' l.f. WELL SCREEN 2" in. dia. 20' l.f. BENTONITE SEAL VOLCLAY PELLETS (1/2"
CASING TYPE PVC SCH #80 SCREEN TYPE STAINLESS STEEL 316 INSTALLATION METHOD POURED
JOINT TYPE FLUSH JOINT-THREADED SLOT SIZE No. 10-0.010 FILTER PACK QTY. ~[illegible] GALS.
GROUT QUANTITY ~350 GALS. CENTRALIZERS NONE FILTER PACK TYPE SILICA SAND
GROUT TYPE VOLCLAY AND CEMENT GROUT (5% BENT.) DRILLING MUD TYPE N/A INSTALLATION METHOD TREMIED WITH WATE[R]

ELEV./DEPTH	SOIL/ROCK DESCRIPTION
253.2	GROUND SURFACE
0.0	0.0-261.0' PONCE FORMATION Soft to mod. hard, dark to pale yellowish orange, mod. weathered LIMESTONE-COBBLES (boulders to cobbles) and c-f SAND, little to some clayey silt. From 16' to 76' occasional seams of soft, reddish brown, SILTY CLAY, trace fine sand.
261.0	Borehole Terminated at 261.0'.

WELL SKETCH



INSTALLATION NOTES

2/19/90 TREMIED 2 1/2 GALS. OF M SAND (DRY). INSTALLED BOTTOM OF #10 SCRE[EN] AT 260.2'. TREMIED 49 GALS. OF MED. SAND WITH WATER. MEASURED AT 239.5'. TREMIED 1[0] GALS. OF M-F SAND. MEASURED AT 235.2'. TREMIED 140 GALS. O[F] VOLCLAY GROUT. TREMIED 15 GA[LS] OF CEMENT (PLUG).
2/20/90 MEASURED DEPTH OF CEMENT PLUG AT 144.2'. TREMIED 195 GALS OF CEMENT GROUT. MEASURED AT 2'.
2/21/90 INSTALLED PROTECTIVE CASING. POURED GRAVEL INSIDE PROTECTIVE CASING.

WELL DEVELOPMENT NOTES

SEE WELL DEVELOPMENT FIELD RECORDS

DRAFT

PROJECT LOCATION: Ponce, P.R. BORING DATE: 2/19/90 DATUM: MSL

PROJECT NUMBER: 893-3803.2 BORING LOCATION: See Remarks

DEPTH SCALE FEET	BORING METHOD	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEV / DEPTH	SAMPLES: NUMBER	TYPE	BLOWS / 6 in	N	REC/ATT	REMARKS	PIEZOMETER OR STANDPIPE INSTALLATION
160	CSR	See previous page.										
170						17	RC	-	-	100%	Moist at 165 ft.	
180						18	RC	-	-	100%		
190						19	RC	-	-	100%		Volclay Grout
200						20	RC	-	-	100%	Moist at 200 ft.	
210						21	RC	-	-	100%		
220						22	RC	-	-	100%		
230						23	RC	-	-	100%	Wet at 232 ft.	
240						24	RC	-	-	100%	Field parameters: @ top 10 ft. of water zone PH: 8.10 Temp.: 27 C Salinity: 0.2 % Conductivity: 2,180 umhos	240.4' 2/19/90
250						25	RC	-	-	100%	@ bottom 10 ft. of water zone PH: 8.54	Filter Sand
260						26	RC	-	-	100%	Temp.: 30 C Salinity: 0.2 % Conductivity: 1,250 umhos	
		Borehole Terminated @ 261 ft.			261.00							
270												
280		NOTES: RC = 3.5" Rock Core CSR = Center Sample Rotary/Reverse Circulation.										
290												
300												
310												
320												

DRILL RIG: AP 1000
DRILLING CONTRACTOR: Dual Tube Inc.
DRILLER: Wesley Jamison

Golder Associates

LOGGED: RIO
CHECKED: WGG
DATE: 4/19/90

PROJECT NUMBER: 893-3803.2

BORING LOCATION: See Remarks

DEPTH SCALE FEET	BORING METHOD	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEV / DEPTH	SAMPLES: NUMBER	TYPE	BLOWS / 6 in	N	REC/ATT	REMARKS	PIEZOMETER OR STANDPIPE INSTALLATION
0		0.0' - 261.0' PONCE FORMATION: Very pale to dark yellowish orange, fossiliferous LIMESTONE Cobbles (10-80%), Gravel (10-70%), Sand (20-60%), Clayey Silt to Silty Clay (10-50%).			253.20 0.00	1	RC	-	-	89%	Ground elevation: 253.2 ft. (77.18 m.) Location: N19,805.2 m.; E128,839.3 m. Jar sample SA-1 taken at 10 ft.	
10		Soft to moderately hard, pale yellowish orange, moderately weathered LIMESTONE-COBBLES and c-f SAND, little silt.			16.00	2	RC	-	-	100%	SA-2 taken at 20 ft.	
20		Soft, dark to pale yellowish orange, mod. weath. fossil. LIMESTONE-COBBLES and c-f SAND, some c-f gravel, little to some clayey silt. @ 30' to 40' occasional layers (0.5 ft.) of soft, reddish brown, silty clay, trace fine sand.				3	RC	-	-	100%	SA-3 taken at 30 ft.	
30						4	RC	-	-	100%		
40						5	RC	-	-	100%	Moist from 42 to 58 ft.	
50						6	RC	-	-	100%	SA-4 taken at 61 ft.	
60						7	RC	-	-	100%	SA-5 taken at 71 ft.	
70		Soft, reddish brown, SILTY CLAY, trace fine sand.	CH		70.00							Cement Grout
	CSR	Soft to mod. hard, pale yellowish orange, mod. weath. fossil. LIMESTONE-COBBLES and c-f SAND, some c-f gravel, little to some clayey silt.			76.00	8	RC	-	-	100%		
80						9	RC	-	-	100%	SA-6 taken at 90 ft. From 92 to 102 ft. iron staining in rock fragments. Small cavities.	
90						10	RC	-	-	90%		
100						11	RC	-	-	100%		
110						12	RC	-	-	100%	SA-7 taken at 121 ft.	
120						13	RC	-	-	100%		
130						14	RC	-	-	100%		
140						15	RC	-	-	100%	SA-8 taken at 151 ft. Moist at 152 ft.	Volclay Grout
150						16	RC	-	-	100%		
160												

DRILL RIG: AP 1000
DRILLING CONTRACTOR: Dual Tube Inc.
DRILLER: Wesley Jamison

Golder Associates

LOGGED: RIO
CHECKED: WGG
DATE: 4/15/90

MONITORING WELL INSTALLATION LOG

JOB NO. 893-380_ PROJECT BFI/RFA/PONCE WELL NO. GW-7 SHEET 1 of 1

GA INSP. RIO DRILLING METHOD CSR- CENTER SAMPLE ROTARY GROUND ELEV. [illegible] FT. ([illegible] M.) WATER DEPTH 283.85 FT

WEATHER PTLY CLOUDY DRILLING COMPANY DUAL TUBE DRILLING INC. COLLAR ELEV. [illegible] FT. ([illegible] M.) DATE/TIME 2/14/90 7:45

TEMP. 80's DRILL RIG AP 1000 DRILLER WESLEY JAMISON STARTED 8:15 2/14/90 (TIME / DATE) COMPLETED 18:30 2/16/9_ (TIME / DATE)

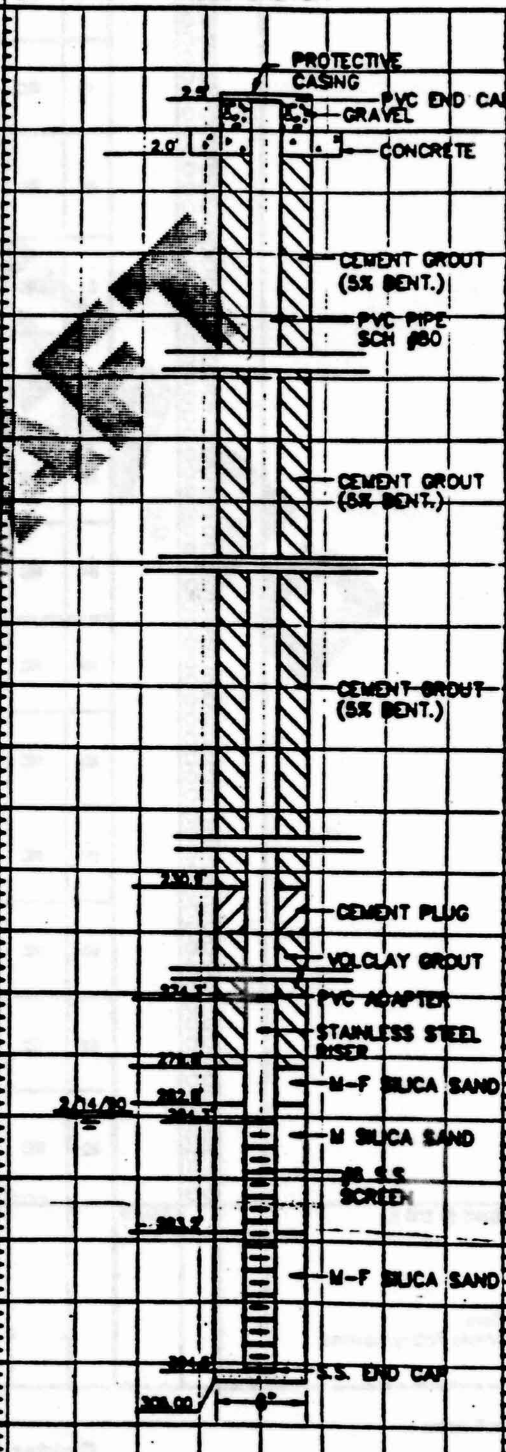
LOCATION / COORDINATES 19,786.32 N (M.), 128,265.78 E (M.)

MATERIALS INVENTORY

WELL CASING	1 7/8" I.D. in. dia. 285' l.f.	WELL SCREEN	2" in. dia. 20' l.f.	BENTONITE SEAL	VOLCLAY GROUT
CASING TYPE	PVC SCH #80	SCREEN TYPE	STAINLESS STEEL 316	INSTALLATION METHOD	POURED
JOINT TYPE	FLUSH JOINT-THREADED	SLOT SIZE	No. 6-0.006"	FILTER PACK QTY.	~37 GALS.
GROUT QUANTITY	~360 GALS.	CENTRALIZERS	NONE	FILTER PACK TYPE	SILICA SAND
GROUT TYPE	VOLCLAY AND CEMENT GROUT (5% BENT.)	DRILLING MUD TYPE	N/A	INSTALLATION METHOD	TREMIED WITH WATER

ELEV./DEPTH	SOIL/ROCK DESCRIPTION
300.8	GROUND SURFACE
0.0	0.0–305.0' PONCE FORMATION Pale yellowish orange c-f SAND and c-f GRAVEL, some limestone-cobbles (boulders to cobbles), little to some clayey silt. Occasional seams of firm to stiff, reddish to yellowish brown, SILTY CLAY, trace fine sand.
119.0	Soft to mod. hard, grayish orange, mod. weathered LIMESTONE-COBBLES and c-f SAND, some clayey silt, little c-f gravel. From 134' to 141' soft, dark greenish gray limey MUDSTONE.
152.0	Stiff, pale yellowish orange, CLAYEY SILT, trace fine sand, trace fine gravel.
163.0	Soft, pale yellowish orange, mod. weathered LIMESTONE-COBBLES and m-f SAND, some clayey silt, little fine gravel.
305.0	Borehole Terminated at 305.0'

WELL SKETCH



INSTALLATION NOTES

2/14/90 TREMIED 1 GAL. OF DRY M-F SAND. INSTALLED BOTTOM OF SCREEN (#6) AT 303'. POURED 5 GALS. OF M-F SAND, SAND GOT BRIDGED IN DRILL PIPE. SCREEN MOVED DOWN 1.5' TO 304.5'. TREMIED 12 MORE GALS. OF M-F SAND, MEASURED A_ 1.5' TO 304.5'. TREMIED 12 MORE GALS. OF M-F SAND. MEASURED 293.2'. TREMIED 20 GALS. OF M SAND, MEASURED AT 282.8'. TREMIED 5 GALS. OF M-F SAND, MEASURED AT 279.8'. TREMIED 140 GALS. OF VOLCLAY GROUT. TREMIED 15 GALS. OF CEMENT.

2/15/90 DEPTH TO CEMENT PLUG MEASURED AT 230.9'. TREMIED ~21_ GALS. OF CEMENT GROUT (5% BENT.). CUT PVC CASING WITH 1.6' STICK UP

2/16/90 INSTALLED PROTECTIVE CASING. POURED GRAVEL (1/2"-3/4_ INSIDE PROTECTIVE CASING.

WELL DEVELOPMENT NOTES

SEE WELL DEVELOPMENT FIELD RECORDS.

PROJECT LOCATION: Ponce, P.R. BORING DATE: 2/14/90 DATUM: MSL

PROJECT NUMBER: 893-3803.2 BORING LOCATION: See Remarks

DEPTH SCALE FEET	BORING METHOD	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEV / DEPTH	SAMPLES: NUMBER	TYPE	BLOWS / 6 in	N	REC/ATT	REMARKS	PIEZOMETER OR STANDPIPE INSTALLATION
160												
		Soft, pale yellowish orange, mod.weath. LIMESTONE-COBBLES and m-f SAND, some clayey silt, little fine gravel.			163.00	17	RC	-	-	100%	SA-14 taken at 165 ft.	
170						18	RC	-	-	100%		
180						19	RC	-	-	100%		
190						20	RC	-	-	100%		Cement Grout
200						21	RC	-	-	100%	SA-15 taken at 202 ft.	
210						22	RC	-	-	100%		
220						23	RC	-	-	100%	Moist from 223 to 253 ft.	
230	CSR					24	RC	-	-	100%		
240						25	RC	-	-	100%		
250						26	RC	-	-	100%	Wet from 253 to 254 ft., then dry to moist. SA-16 taken at 261 ft.	Volclay Grout
260						27	RC	-	-	100%	Moist to wet from 263 to 264 ft., then moist.	
270						28	RC	-	-	100%		
280						29	RC	-	-	100%	Very wet from 283 to 293 ft. @ 293 ft. hole started to produce water. Took field parameters (see below). SA-17 taken at 292 ft.	283.9' 2/14/90 Filter Sand
290						30	RC	-	-	100%	SA-18 taken at 297 ft. Field parameters: PH: 8.11 Temp.: 23 C Salinity: 0.5 % Conductivity: 1,490 umhos	
300												
		Borehole Terminated @ 305 ft.			305.00							
310												
320		NOTES: RC = 3.5" Rock Core. CSR = Center Sample Rotary/Reverse Circulation.										

DRILL RIG: AP 1000
DRILLING CONTRACTOR: Dual Tube Inc.
DRILLER: Wesley Jamison

Golder Associates

LOGGED: RO
CHECKED: WGG
DATE: 4/15/90

PROJECT: BFI/RFA/PONCE

PROJECT LOCATION: Ponce, P.R.

PROJECT NUMBER: 893-3803.2

RECORD OF BOREHOLE GW-7

BORING DATE: 2/14/90

BORING LOCATION: See Remarks

DATUM: MSL

BORING METHOD: CSR

SOIL PROFILE

DESCRIPTION	USCS	ELEV / DEPTH
		300.80 / 0.00
0.0' - 305.0' PONCE FORMATION: Very pale to dark yellowish orange, fossiliferous LIMESTONE Cobbles (10-80%), Gravel (10-70%), Sand (20-80%), Clayey silt to Silty Clay (10-50%). Pale yellowish orange, c-f SAND, some c-f gravel, little clayey silt.	SM-SC	
Pale to very pale yellowish orange, m-f SAND, little to some clayey silt, little c-f gravel.	SM-SC	20.00
Pale yellowish orange, c-f SAND and c-f GRAVEL, some limestone-cobbles, little to some clayey silt. Occasional layers (0.5 ft.) of firm to stiff, reddish brown, silty clay, trace fine sand.	GM-GC	30.00
Stiff to very stiff, yellow brown, SILTY CLAY, trace fine sand.	CH	64.00
Pale yellowish orange, c-f SAND, little to some c-f gravel, little to some clayey silt.	SM-SC	70.00
Pale yellowish orange, c-f SAND and c-f GRAVEL, some limestone-cobbles, little to some clayey silt. @ 116 ft. layer (0.5 ft.) of firm to stiff, reddish brown, silty clay, trace fine sand.	GM-GC	82.00
Soft to moderately hard, grayish orange, moderately weathered LIMESTONE-COBBLES and c-f SAND, some clayey silt.	-	119.00
Soft, dark greenish gray, unweathered limey MUDSTONE.	-	134.00
Soft to mod. hard, grayish orange to pale yellowish orange, mod. weath. LIMESTONE-COBBLES and c-f SAND, some clayey silt, little c-f gravel.	-	141.00
Stiff, pale yellowish orange, CLAYEY SILT, trace fine sand, trace fine gravel.	MH	152.00

SAMPLES

NUMBER	TYPE	BLOWS / 6 in	N	REC/ATT
1	RC	-	-	100%
2	RC	-	-	100%
3	RC	-	-	100%
4	RC	-	-	100%
5	RC	-	-	88%
6	RC	-	-	100%
7	RC	-	-	100%
8	RC	-	-	100%
9	RC	-	-	100%
10	RC	-	-	100%
11	RC	-	-	100%
12	RC	-	-	100%
13	RC	-	-	100%
14	RC	-	-	100%
15	RC	-	-	88%
16	RC	-	-	100%

REMARKS

Ground elevation: 300.8 ft. (91.62 m.)
Location: N19,796.3 m.; E128,265.8 m.
Jar sample SA-1 taken at 10 ft.
SA-2 taken at 20 ft.
SA-3 taken at 31 ft.
SA-4 taken at 41 ft.
42'-46' Driller noted small cavities.
SA-5 taken at 46 ft.
SA-6 taken at 58 ft.
SA-7 taken at 61 ft.
SA-8 taken at 64 ft.
66'-72' used water during drilling
SA-9 taken at 80 ft.
SA-10 taken at 120 ft.
SA-11 taken at 139 ft.
SA 12 taken at 141 ft.
Moist from 142' to 143'
Moist to wet from 147 to 149 ft.
SA-13 taken at 154 ft.

PIEZOMETER OR STANDPIPE INSTALLATION

Cement Grout

DRILL RIG: AP 1000

DRILLING CONTRACTOR: Dual Tube Inc.

DRILLER: Wesley Jamison

Golder Associates

LOGGED RO

CHECKED WGG

DATE 4/15/90

MONITORING WELL INSTALLATION LOG

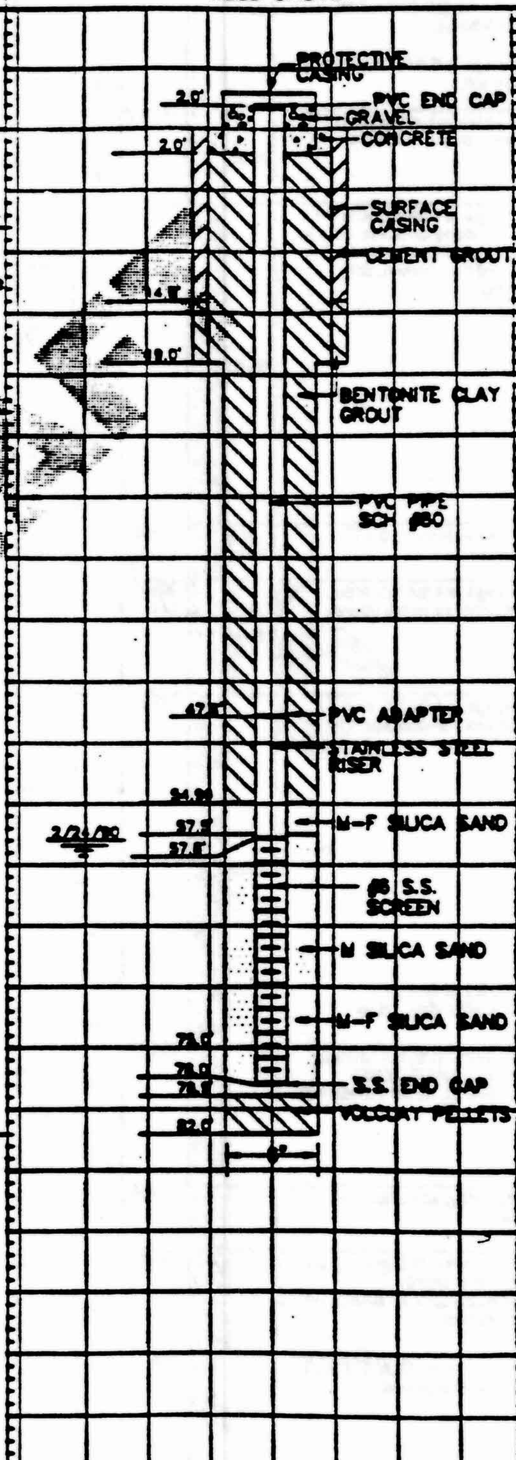
JOB NO.	893-3803.2	PROJECT	BFI/RFA/PONCE	WELL NO.	GW-5
SHEET	1 of 1	GA INSP.	RIO	DRILLING METHOD	CSR- CENTER SAMPLE ROTARY
GROUND ELEV.	[illegible]	WATER DEPTH	57.9'	WEATHER	PTLY CLOUDY
DRILLING COMPANY	DUAL TUBE DRILLING INC.	COLLAR ELEV.	[illegible]	DATE/TIME	16:50 2/24/
TEMP.	80's	DRILL RIG	AP 1000	DRILLER	WESLEY JAMISON
STARTED (TIME / DATE)	09:30 2/23/90	COMPLETED (TIME / DATE)	17:15 2/24/	LOCATION / COORDINATES	19,457.93 N (M.), 128,866.57 E (M.)

MATERIALS INVENTORY

WELL CASING	1 7/8" I.D. in. dia. 48' l.f.	WELL SCREEN	2" in. dia. 20' l.f.	BENTONITE SEAL	BENTONITE GROUT
CASING TYPE	PVC SCH #80	SCREEN TYPE	STAINLESS STEEL 316	INSTALLATION METHOD	TREMIED
JOINT TYPE	FLUSH JOINT-THREADED	SLOT SIZE	No. 6 - 0.006"	FILTER PACK QTY.	~42 GALS.
GROUT QUANTITY	~190 GALS.	CENTRALIZERS	NONE	FILTER PACK TYPE	SILICA SAND
GROUT TYPE	PURE GOLD BENTONITE CLAY AND CEMENT	DRILLING MUD TYPE	N/A	INSTALLATION METHOD	TREMIED WITH WATER

ELEV./DEPTH	SOIL/ROCK DESCRIPTION
159.7	GROUND SURFACE
0.0	Fill-pale yellowish orange, c-f SAND and c-f GRAVEL, some clayey silt.
8.0	Mod. hard to hard, very pale orange to pale red, mod. weathered, crystaline LIMESTONE-COBBLES (blouders to cobbles) and c-f GRAVEL, some c-f sand.
23.0	Interbeded layers of soft, dark to pale yellowish orange, mod. weathered, limey SILTSTONE-COBBLES and c-f GRAVEL, some c-f sand, little to some clayey silt; ~~and c-f SAND, c-f GRAVEL, and CLAYEY SILT.~~
82.00	Borehole Terminated at 82.0'.

WELL SKETCH



INSTALLATION NOTES

2/26/90 INSTALLED SURFACE CASING 8" I.D. (8 1/2" O.D.) AT 19' IN 10" HOLE. TREMIED BENTONITE GROUT AROUND SURFACE CASING ANNULUS. GROUT CAME UP INSIDE CASING 1". DRILLED HOLE THROUGH CASING MEASURED DEPTH 81.8'. POURED 2 GALS. OF VOLCLAY PELLETS. MEASURED 78.9'. POURED 1 GAL. OF M-F SAND EXPECTED DEPTH ~78.4'. INSTALL 20' STAINLESS STEEL SCREEN BOTTOM AT 78.0' BGS. INSTALLED 10' STAINLESS STEEL RISER AND 10' PVC CASING TO SURFACE, STICK UP ~2'. TREMIED 7 1/2 GALS. OF M-F SAND. MEASURED AT 75.0' BGS. TREMIED 20 GALS OF SILICA SAND TO 57.8' BGS. TREMIED 4 1/2 GALS. OF F-M SILICA SAND TO 54.9' BGS. TREMIED 140 GALS. (8 BAGS OF PURE GOLD GROUT). TREMIED 50 GALS. OF CEMENT GROUT. PLACED PROTECTIVE SURFACE CASING (WITH CEMENT ~3 BAGS). PLACED GRAVEL IN CASING (6" FROM CAP). PLACED LOCK ON SURFACE CASING AND PLACED CAP ON PVC.

PROJECT LOCATION: Ponce, P.R. BORING DATE: 2/24/90 DATUM: MSL

PROJECT NUMBER: 893-3803.2 BORING LOCATION: See Remarks

DEPTH SCALE FEET	BORING METHOD	DESCRIPTION	USCS	ELEV / DEPTH	NUMBER	TYPE	BLOWS / 6 in	N	REC/ATT	REMARKS	PIEZOMETER OR STANDPIPE INSTALLATION
0	CSR			159.70							
		Fill- Pale yellowish orange, c-f SAND and c-f GRAVEL, some clayey silt.	GM-GC	0.00	1	RC	-	-	100%	Ground elevation: 159.7 ft. (48.69 m.) Location: N19,457.9 m.; E128,886.6 Jar Sample SA-1 taken at 4 ft. SA-2 taken at 8 ft. SA-3 taken at 14 ft.	
10		Moderately (mod.) hard to hard, very pale orange to pale red, mod. weathered (weath.) sparry LIMESTONE-COBBLES, trace to little coarse gravel.		8.00	2	RC	-	-	100%		
20		Soft, dark to pale yellowish orange, mod. weath., limey SILTSTONE-COBBLES and c-f GRAVEL, some c-f sand, little to some clayey silt. From 44 to 45 ft. hard, crystaline LIMESTONE.		23.00	3	RC	-	-	100%	Moist from 23 to 49 ft. SA-4 taken at 25 ft.	Volclay Grout
30					4	RC	-	-	100%		
40					5	RC	-	-	100%		
50		Dark to pale yellowish orange, c-f SAND and c-f GRAVEL, some clayey silt.	GM-GC	48.00	6	RC	-	-	100%	Moist from 58 to 76 ft.	57.9' 2/24/90
60		Soft, dark to pale yellowish orange, mod. weath., limey SILTSTONE-COBBLES and c-f GRAVEL, some c-f sand, little to some clayey silt.		56.00	7	RC	-	-	100%		Filter Sand
70		Dark yellowish orange c-f SAND and CLAYEY SILT, some c-f gravel, some limey siltstone-cobbles.	SM-SC	76.00	8	RC	-	-	100%	SA-6 taken at 71 ft. Wet from 76 to 82 ft. SA-7 taken at 78 ft. @ 82 ft. produced water. Took field parameters. Field parameters: PH: 6.61 Temp.: 26.6 C Salinity: 9.2% Conductivity: 20,900 umhos	Volclay Pellets
80		Borehole Terminated @ 82 ft.		82.00							
90											
100		NOTES: RC = 3.5" Rock Core. CSR = Center Sample Rotary/Reverse Circulation.									
110											
120											
130											
140											
150											
160											

DRILL RIG: AP 1000

DRILLING CONTRACTOR: Dual Tube Inc.

DRILLER: Wesley Jamison

Golder Associates

LOGGED: RIC

CHECKED: WGG

DATE: 4/14/90

JOB NO. 893-3803.2 PROJECT BFI/RFA/PONCE WELL NO. GW-4 SHEET 1 of __

GA INSP. RIO DRILLING METHOD CSR- CENTER SAMPLE ROTARY GROUND ELEV. [illegible] FT. ([illegible] M.) WATER DEPTH 137.[illegible]

WEATHER SU[illegible] DRILLING COMPANY DUAL TUBE DRILLING INC. COLLAR ELEV. [illegible] FT. ([illegible] M.) DATE/TIME 1/16/90 [illegible]

TEMP. 80's DRILL RIG AP 1000 DRILLER WESLEY JAMISON STARTED 8:30 1/16/90 (TIME / DATE) COMPLETED 17:00 1/1[illegible] (TIME / DATE)

LOCATION / COORDINATES 19,560.19 N (M.), 128,827.90 E (M.)

MATERIALS INVENTORY

WELL CASING 1 7/8" I.D. in. dia. 126' Lf. WELL SCREEN 2" in. dia. 20' Lf. BENTONITE SEAL VOLCLAY PELLETS (1/[illegible]

CASING TYPE PVC SCHED. #80 SCREEN TYPE STAINLESS STEEL 316 INSTALLATION METHOD POURED W/WATER

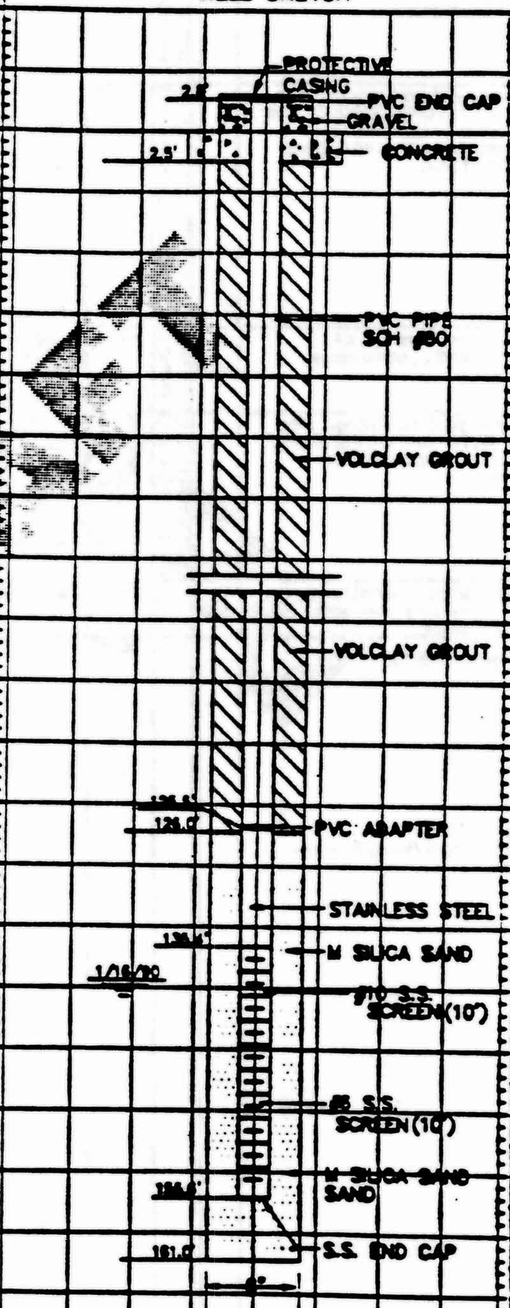
JOINT TYPE FLUSH JOINT-THREADED SLOT SIZE No. 6 AND No. 10 FILTER PACK QTY. ~33 GALS.

GROUT QUANTITY ~330 GALS. CENTRALIZERS NONE FILTER PACK TYPE SILICA SAND

GROUT TYPE VOLCLAY GROUT DRILLING MUD TYPE NONE AIR/WATER INSTALLATION METHOD TREMIED WITH WAT[illegible]

ELEV./DEPTH	SOIL/ROCK DESCRIPTION
203.6	0.0–145.0' PONCE FORMATION; GROUND SURFACE
0.0 – 10.0	Pale yellowish orange, m–f SAND, little to some clayey silt, little c–f gravel.
10.0 – 145.00	Soft to mod. hard, pale yellowish orange, mod. weathered, fossil. LIME-STONE-COBBLES (boulders to cobbles) and c–f GRAVEL, some m–f sand, some clayey silt.
145.00 – 161.00	Soft to mod. hard, dark greenish gray, unweathered, limey MUDSTONE. From 150' to 151' layer of soft, limey SANDSTONE. (Juana Diaz Fm)
161.00	Borehole Terminated at 161.0'

WELL SKETCH



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INSTALLATION NOTES

1/16/90 MEASURED DEPTH OF H[illegible] AT 161'. POURED 5 GALS OF M SAND. INSTALLED BOTTOM OF SCREEN AT 155.9' TREMIED 28 GALS. OF M SAND. MEASURED A[illegible] 126.0'. TREMIED 110 GALS. OF VOLCLAY GROUT.

1/17/90 TREMIED 120 GALS. OF VOLCLAY GROUT. THE HOLE TO[illegible] A LOT OF GROUT.

POURED 2 GALS. OF GRAVEL TO REDUCE HIGH GROUT TAKE. MEAS[illegible]URED AT 15'. TREMIED 50 GALS VOLCLAY GROUT WHILE POURING GALS. OF GRAVEL. MEASURED A[illegible] ~4'. TREMIED ~50 GALS. VOLC[illegible] GROUT.

2/18/90 INSTALLED PROTECTIVE CASING.

WELL DEVELOPMENT NOTES

SEE WELL DEVELOPMENT FIELD RECORDS.

PROJECT LOCATION: Ponce, P.R.
PROJECT NUMBER: 893-3803.2
BORING DATE: 2/5/90
BORING LOCATION: See Remarks
DATUM: MSL

DEPTH SCALE FEET	BORING METHOD	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEV / DEPTH	SAMPLES: NUMBER	TYPE	BLOWS / 6 in	N	REC/ATT	REMARKS	PIEZOMETER OR STANDPIPE INSTALLATION
0		0.0' - 400.0' PONCE FORMATION: Very pale to dark yellowish orange, fossiliferous LIMESTONE Cobbles (10-80%), Gravel (10-70%), Sand (20-60%), Clayey Silt to Silty Clay (10-50%).			389.30 / 0.00	1	RC	-	-	80%	Ground elevation: 389.3 ft. (121.71 m.) Location: N19,790.5 m.; E128,909.0 m. Jar sample SA-1 taken at 10 ft.	
10		Very pale to pale yellowish orange, CLAYEY SILT, little to some fine sand, little to some c-f gravel, trace limestone-cobbles.				2	RC	-	-	80%		
20			MH			3	RC	-	-	100%	Slightly moist at 22 ft.	
30						4	RC	-	-	100%	SA-2 taken at 31 ft.	
40		Soft, pale yellowish orange, moderately weathered LIMESTONE-COBBLES and c-f GRAVEL, little clayey silt.	-		45.00	5	RC	-	-	80%	Cavities and small voids from 45 to 60 ft. SA-3 taken at 50 ft.	
50		Pale yellowish orange, c-f GRAVEL and CLAYEY SILT, some fossiliferous sparry limestone-cobbles, little to some fine sand.			52.00	6	RC	-	-	80%		
60						7	RC	-	-	86%		
70	CSR					8	RC	-	-	100%	SA-4 taken at 80 ft.	Volclay Grout
80						9	RC	-	-	100%		
90						10	RC	-	-	100%		
100						11	RC	-	-	100%	SA-5 taken at 110 ft.	
110			GM-G[illegible]			12	RC	-	-	100%		
120						13	RC	-	-	89%	122'-132' driller notes material drills like it has small cavities. SA-6 taken at 130 ft.	
130						14	RC	-	-	100%		
140						15	RC	-	-	100%		
150–160						16	RC	-	-	100%		

DRILL RIG: AP 1000
DRILLING CONTRACTOR: Dual Tube Inc.
DRILLER: Wesley Jamison

Golder Associates

LOGGED: RIO
CHECKED: WGG
DATE: 4/28/90

DEPTH SCALE FEET	BORING METHOD	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEV / DEPTH	SAMPLES: NUMBER	TYPE	BLOWS / 6 in	N	REC/ATT	REMARKS	PIEZOMETER OR STANDPIPE INSTALLATION
160		See previous page.										
170						17	RC	-	-	100%		
180						18	RC	-	-	100%		
						19	RC	-	-	80%	SA-8 taken at 188 ft.	
190		Stiff, reddish brown and black, SILTY CLAY, little to trace fine sand.	CH		187.00						SA-9 taken at 190 ft. From 190 to 192 ft. black color may be due to manganese.	Volclay Grout
		Pale yellowish orange, CLAYEY SILT and c-f GRAVEL, some fine sand, some fossil. limestone-cobbles.			192.00	20	RC	-	-	80%		
200						21	RC	-	-	100%		
210						22	RC	-	-	100%		
220						23	RC	-	-	100%	SA-10 taken at 228 ft.	
230						24	RC	-	-	100%		
240	CSR		SM-G			25	RC	-	-	80%		
250						26	RC	-	-	100%	SA-11 taken at 260 ft.	
260						27	RC	-	-	100%		
270						28	RC	-	-	100%		
280		Soft to hard, very pale to pale yellowish orange, mod. weath., fossil. LIMESTONE-COBBLES and slightly CLAYEY SILT, some c-f gravel, some fine sand.			286.00	29	RC	-	-	100%	286'-291' Hard fossil. limestone. SA-12 taken at 290 ft.	
290						30	RC	-	-	100%		
300		Very pale to pale yellowish orange, CLAYEY SILT and fossil. LIMESTONE-COBBLES, some c-f gravel, some fine sand.			302.00	31	RC	-	-	100%	SA-13 taken at 310 ft.	
310						32	RC	-	-	100%		
320												

RECORD OF BOREHOLE GW-3

PROJECT: BFI/RFA/PONCE
PROJECT LOCATION: Ponce, P.R.
PROJECT NUMBER: 893-3803.2
BORING DATE: 2/5/90
BORING LOCATION: See Remarks
SHEET: 3 OF 3
DATUM: MSL

DEPTH SCALE FEET	BORING METHOD	SOIL PROFILE DESCRIPTION	USCS	ELEV / DEPTH	SAMPLES NUMBER	TYPE	BLOWS / 6 in	N	REC/ATT	REMARKS	PIEZOMETER OR STANDPIPE INSTALLATION
320	CSR	See previous page.								@ 320 ft. gradational color change, soil becomming slightly moist.	Volclay Grout
					33	RC	-	-	100%	SA-14 taken at 330 ft.	
330–340					34	RC	-	-	100%		
340–350					35	RC	-	-	100%		
350–360		From 357 to 362 ft. predominantly LIMESTONE.			36	RC	-	-	100%		
360–370		Pale yellowish orange, fine SAND and c-f GRAVEL, some limestone-cobbles, some clayey silt.	GM-GC	362.00	37	RC	-	-	100%		
370–380					38	RC	-	-	100%	SA-15 taken at 380 ft.	
380–390					39	RC	-	-	100%		385.6 2/7/90
390–400					40	RC	-	-	100%	Wet from 392 to 407 ft., then gradually becomes dry @ 411 ft. @ 410'-412' took field parameters. Field parameters: PH: 7.95 Temp.: 34 C Conductivity: 1480 umhos	Filter Sand
400		Soft, dark greenish gray, fossil. MUDSTONE (Juana Diaz Fm.)		400.00							
402		Soft, dark greenish gray and white mottled SILTY CLAY, some m-f sand.	CL	402.00	41	RC	-	-	100%		Bentonite Cuttings
412		Borehole Terminated @ 412 ft.		412.00							

NOTES:
RC = 3.5" Rock Core.
CSR = Center Sample Rotary/Reverse Circulation.

DRILL RIG: AP 1000
DRILLING CONTRACTOR: Dual Tube Inc.
DRILLER: Wesley Jamison

LOGGED: RIO
CHECKED: WGG
DATE: 4/25/90

Golder Associates

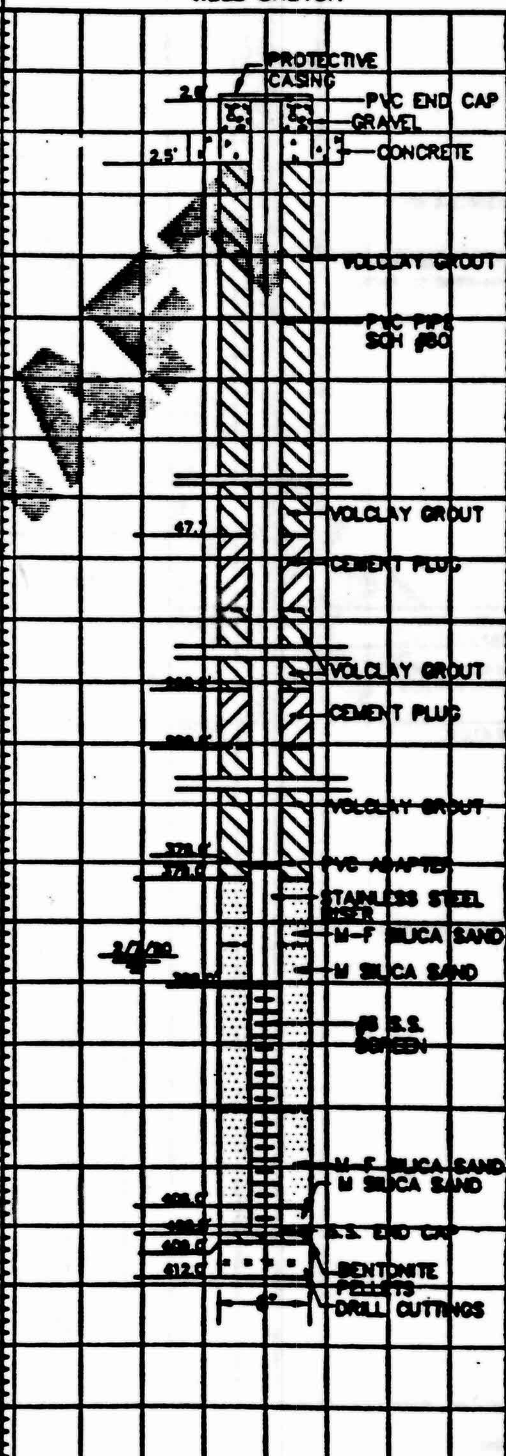
MONITORING WELL INSTALLATION LOG

JOB NO. 893-3803.2 PROJECT BFI/RFA/PONCE WELL NO. GW-3 SHEET 1 of 1
GA INSP. WGG AND RIQ DRILLING METHOD CSR- CENTER SAMPLE ROTARY GROUND ELEV. [illegible] WATER DEPTH 385.6'
WEATHER PTLY CLOUDY DRILLING COMPANY DUAL TUBE DRILLING INC. COLLAR ELEV. [illegible] DATE/TIME 2/7/90 9:15
TEMP. 80's DRILL RIG AP 1000 DRILLER WESLEY JAMISON STARTED 8:00 2/6/90 (TIME / DATE) COMPLETED 17:10 2/10/90 (TIME / DATE)
LOCATION / COORDINATES 19,790.54 N (M.), 128,908.99 E (M.)

MATERIALS INVENTORY

WELL CASING 1 7/8" I.D. in. dia. 390' l.f. WELL SCREEN 2" in. dia. 20' l.f. BENTONITE SEAL VOLCLAY GROUT
CASING TYPE PVC SCH #80 SCREEN TYPE STAINLESS STEEL 316 INSTALLATION METHOD TREMIED
JOINT TYPE FLUSH JOINT-THREADED SLOT SIZE No. 6 - 0.006" FILTER PACK QTY. ~49 GALS.
GROUT QUANTITY 1210 GALLONS CENTRALIZERS NONE FILTER PACK TYPE SILICA SAND
GROUT TYPE VOLCLAY AND CEMENT DRILLING MUD TYPE NA INSTALLATION METHOD TREMIED WITH WATER

ELEV./DEPTH	SOIL/ROCK DESCRIPTION	WELL SKETCH
399.3	GROUND SURFACE	
0.0	0.0-402.0' PONCE FORMATION Soft, very pale to pale yellowish orange, mod. weathered, foss. LIMESTONE-COBBLES (boulders to cobbles), some clayey silt, little to some c-f gravel. Occasional layers of clayey silt. From 187' to 192' stiff, reddish brown, SILTY CLAY.	
402.0	Soft, dark greenish grey SILTY CLAY and f-m SAND. (Juana Diaz Fm)	
412.0	Borehole Terminated at 412.0'.	



INSTALLATION NOTES

2/6/90 MEASURED DEPTH OF HOLE AT 407' THEN FLUSHED/CLEANED HOLE TO TOTAL DEPTH (412'). MEASURED TD AT ~409'- SOFT BOTTOM. ADDED 2 GALS. BENT. PELLETS MEASURED BTM. AT ~408'.; ADDED ~3.5 GALS. MED. SAND, MEASURED AT ~406'. INSTALLED WELL PIPE - SEE DIAG. AND INVENTORY. WELL SUNK ~2'- HAD TO PULL BACK UP. SAND WOULD NOT HOLD IT. TREMIED ~49 GALS. OF SAND TOTAL DOWN-HOLE. SAND TO ~379'. NOTE: WELL CONTINUED TO OCCASIONALLY SLIP DOWNHOLE ~0.5'.

2/7/90 TREMIED ~105 GALS. OF VOLCLAY THEN ADDED 15 GALS. OF CEMENT TO HOLD WELL. FINISHED W/ CEMENT AT 12:00.
2/8/90 MEASURED CEMENT AT 268'. TREMIED ~540 GALS. OF VOLCLAY THEN ADDED 7 GALS. OF CEMENT TO MINIMIZE WEIGHT OF REMAINING GROUT. RODS WERE PULLED OUT OF HOLE.
2/9/90 MEASURED TOP OF CEMENT PLUG ~47.7. TREMIED ~470 GALS. OF VOLCLAY, THEN POURED 3 1/2 GALS. OF VOLCLAY PELLETS TO PLUG CAVITIES AT ~40' TO 47'. ADDED ~7 GALS. OF GRAVEL WHILE GROUTING TO REDUCE HIGH TAKE OF GROUT. TREMIED ~73 GALS. OF VOLCLAY UP TO GROUND SURFACE
2/10/90 GROUT SETTLED 3.5' INSTALLED PROTECTIVE COVER.

PROJECT LOCATION: Ponce, P.R.
PROJECT NUMBER: 893-3803.2

BORING DATE: 1/15/90
BORING LOCATION: See Remarks

DATUM: MSL

DEPTH SCALE FEET	BORING METHOD	SOIL PROFILE: DESCRIPTION	USCS	ELEV / DEPTH	SAMPLES: NUMBER	TYPE	BLOWS / 6 in	N	REC/ATT	REMARKS	PIEZOMETER OR STANDPIPE INSTALLATION
0	CSR	0.0' - 145.0' PONCE FORMATION: (see remarks) Pale yellowish orange, m-f SAND, little to some clayey silt, little c-f gravel.	SM-SC	203.60 0.00	1	RC	-	-	100%	Ground elevation: 203.6 ft. (62.07 m.) Location: N19,560.2 m.; E128,827.9 m. Jar sample SA-1 taken at 5 ft. PONCE FORMATION: Very pale to dark yellowish orange, fossiliferous LIMESTONE Cobbles (10-80%), Gravel (10-70%), Sand (20-80%), Clayey Silt to Silty Clay. (10-50%).	Voclay Grout
10		Soft to moderately (mod.) hard, pale yellowish orange, mod. weathered (weath.), fossiliferous (fossil.) LIMESTONE-COBBLES and c-f GRAVEL, some m-f sand, some clayey silt.	-	12.00	2	RC	-	-	100%		
20		Pale yellowish orange, c-f GRAVEL, some m-f sand, some clayey silt, occasional cobbles.	GM-GC	20.00	3	RC	-	-	80%	Small cavities from 27 to 40 ft.	
30					4	RC	-	-	0%		
40		Soft, dark to pale yellowish orange, mod. weath., LIMESTONE-COBBLES and c-f GRAVEL, some m-f sand, some clayey silt.		40.00	5	RC	-	-	20%		
50					6	RC	-	-	100%		
60		Dark to pale yellowish orange, c-f GRAVEL, some m-f sand, some clayey silt, occasional cobbles.	GM-GC	[illegible]	7	RC	-	-	100%		
70					8	RC	-	-	100%		
80		Soft to mod. hard, dark to pale yellowish orange, mod. weath., LIMESTONE-COBBLES and c-f GRAVEL, little to some m-f sand, some clayey silt.		78.00	9	RC	-	-	100%		
90					10	RC	-	-	100%		
100					11	RC	-	-	100%		
110					12	RC	-	-	100%		
120					13	RC	-	-	100%	Iron staining from 120 to 121 ft. SA-2 taken at 128 ft.	
130					14	RC	-	-	100%		
140		Soft to mod. hard, dark greenish gray, unweathered, limey MUDSTONE. From 150 to 151 ft. layer of soft, limey sandstone. (Juana Diaz Formation)		145.00	15	RC	-	-	100%	Iron staining from 140 to 141 ft. SA-3 taken at 148 ft.	137.8' 1/16/90 Filter Sand
150					16	RC	-	-	100%	@ 149 and 151 ft. slickensided planar fractures along core axis. Produced 1.2 gal/min for bottom 10 ft. of hole. @ 155 ft. took field parameters.	
160											

DRILL RIG: AP 1000
DRILLING CONTRACTOR: Dual Tube Inc.
DRILLER: Wesley Jamison

Golder Associates

LOGGED: RIO
CHECKED: WGG
DATE: 4/14/90

PROJECT LOCATION: Ponce, P.R.
PROJECT NUMBER: 893-3803.2

BORING DATE: 1/15/90
BORING LOCATION: See Remarks

SHEET: 2 OF 2
DATUM: MSL

DEPTH SCALE FEET	BORING METHOD	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEV / DEPTH	SAMPLES: NUMBER	TYPE	BLOWS / 6 in	N	REC/ATT	REMARKS	PIEZOMETER OR STANDPIPE INSTALLATION
160		Borehole Terminated @ 161 ft.			161.00						Field parameters: PH: 7.9 Temp.: 34 C Salinity: 4.5% Conductivity: 9,500 umhos @ 159 ft. took field parameters. Field parameters: PH: 7.81 Temp.: 30 C Salinity: 4.1% Conductivity: 8,100 umhos	
170												
180												
190		NOTES: RC = 3.5" Rock Core. CSR = Center Sample Rotary/Reverse Circulation.										
200												
210												
220												
230												
240	CSR											
250												
260												
270												
280												
290												
300												
310												
320												

DRAFT

DRILL RIG: AP 1000
DRILLING CONTRACTOR: Dual Tube Inc.
DRILLER: Wesley Jamison

Golder Associates

LOGGED: RIO
CHECKED: WGG
DATE: 4/14/90

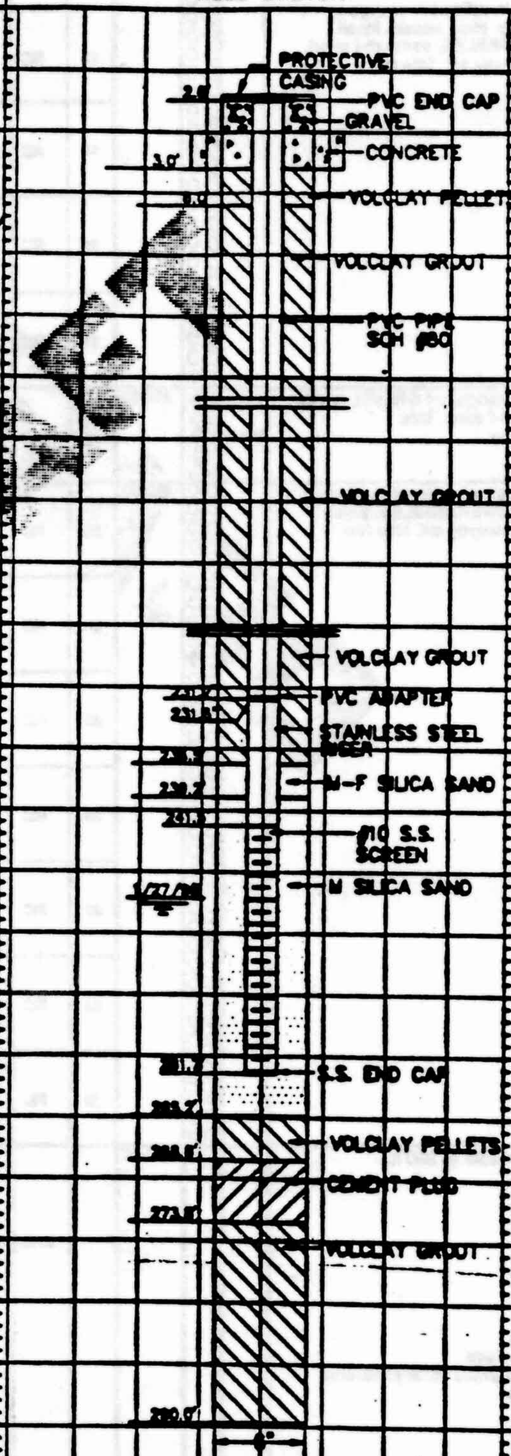
GA INSP. RIO	DRILLING METHOD CSR- CENTER SAMPLE ROTARY		WELL NO.	SHEET 1 of 1	
WEATHER PTLY CLO	DRILLING COMPANY DUAL TUBE DRILLING INC.		GROUND ELEV. [illegible]	WATER DEPTH 246.8 F	
TEMP. 80's	DRILL RIG AP 1000	DRILLER WESLEY JA[illegible]ON	STARTED 8:30 1/27/90 (TIME / DATE)	COLLAR ELEV. [illegible]	DATE/TIME 1/27/90 8:3[illegible]
LOCATION / COORDINATES 19,882.06 N (M.), 128,638.43 E (M.)				COMPLETED 9:30 1/31/9[illegible] (TIME / DATE)	

MATERIALS INVENTORY

WELL CASING 1 7/8" I.D. in. dia. 231' L.f.	WELL SCREEN 2" in. dia. 20' L.f.	BENTONITE SEAL VOLCLAY GROUT
CASING TYPE PVC SCH #80	SCREEN TYPE STAINLESS STEEL 316	INSTALLATION METHOD POURED-TREMIED
JOINT TYPE FLUSH JOINT-THREADED	SLOT SIZE No. 10-0.01"	FILTER PACK QTY. ~36 GALS.
GROUT QUANTITY 630 GALLONS	CENTRALIZERS NONE	FILTER PACK TYPE SILICA SAND
GROUT TYPE VOLCLAY AND CEMENT	DRILLING MUD TYPE N/A	INSTALLATION METHOD TREMIED WITH WATER

ELEV./DEPTH	SOIL/ROCK DESCRIPTION
261.7	GROUND SURFACE
0.0 – 7.0	FILL-Soft, pale yellowish orange, foss. LIMESTONE-COBBLES (bloulders to cobbles) some m-f sand, some clayey silt.
7.0 – 118.0	7.0'-290.0' PONCE FORMATION Pale yellowish orange, fine SAND, some clayey silt, little limestone-cobbles From 64' to 69' layer of soft, yellowish brown, SILTY CLAY.
118.0 – 290.0	Soft to hard yellowish orange, mod. weathered, foss. LIMESTONE-COBBLES and m-f SAND, little to some clayey silt, little to some m-f gravel. From 142' to 145' layer of soft, dark greenish gray, limey MUDSTONE.
290.0	Borehole Termined at 290.0'

WELL SKETCH



INSTALLATION NOTES

1/27/90 TREMIED 30 GALS OF VOLCLAY, MEASURED AT 273.8'. TREMIED 7 GALS. OF CEMENT GRO[illegible] MEASURED AT 268.8'. 1/29/90 POURED 5 GALS. OF VOLCLAY PELLETS, MEASURED AT 265.2'. TREMIED 4.5 GALS. OF M FILTER SAND, MEASURED AT 261.7' INSTALLED BOTTOM OF SCREEN AT 261.7'. TREMIED 36 GALS. OF M FILTER SAND, MEASURED AT 239.2 TREMIED 3 GALS. OF M-F FILTER SAND, MEASURED AT 236.5'. TREM[illegible] 600 GALS. OF VOLCLAY (VERY HIGH TAKE IN LAST 10') 1/31/90 INSTALLED PROTECTIVE CASING.

WELL DEVELOPMENT NOTES

SEE WELL DEVELOPMENT FIELD RECORDS.

RECORD OF BOREHOLE GW-2

PROJECT: BFI/RFA/PONCE
PROJECT LOCATION: Ponce, P.R.
PROJECT NUMBER: 893-3803.2

BORING DATE: 1/26/90
BORING LOCATION: See Remarks

SHEET: 2 OF 2
DATUM: MSL

DEPTH SCALE FEET	BORING METHOD	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEV / DEPTH	SAMPLES: NUMBER	TYPE	BLOWS / 6 in	N	REC/ATT	REMARKS	PIEZOMETER OR STANDPIPE INSTALLATION
160												
		Stiff, reddish brown, SILTY CLAY, little fine sand.	CL		[illegible]	17	RC	-	-	80%		
170		Soft to hard, pale yellowish orange to very pale orange, mod. weath. fossil. LIMESTONE-COBBLES, some m-f sand, little to some clayey silt, little c-f gravel.				18	RC	-	-	100%		
180						19	RC	-	-	100%		
190						20	RC	-	-	100%	SA-10 taken at 194 ft.	Volclay Grout
200						21	RC	-	-	100%		
210		Pale yellowish orange, c-f GRAVEL, some clayey silt, little c-f sand, little limestone-cobbles.	GM-GC		210.00	22	RC	-	-	80%	Cavity from 217 to 218 ft. SA-11 taken at 218 ft. @ 220 ft. started adding drilling water.	
220	CSR	Soft to hard, pale yellowish orange, mod. weath., LIMESTONE-COBBLES, some c-f gravel, some clayey silt, little fine sand.			220.00	23	RC	-	-	100%		
230						24	RC	-	-	80%	Small cavities from 230 to 240 ft.	
240						25	RC	-	-	100%		
250						26	RC	-	-	100%	Rock fragments from 250 to 260 ft. show iron staining.	248.9' 1/27/90; Filter Sand
260						27	RC	-	-	100%		Volclay Pellets
270						28	RC	-	-	100%		Cement
280						29	RC	-	-	100%	@ 278 ft. encountered water. Rock fragments at 279 ft. show iron staining. Water production @ 280 ft. of 1.5 gal. in 8 min. Field parameters: PH: 7.95 Temp.: 30.5 C Salinity: 0 % Conductivity: 920 umhos	Volclay Grout
290		Borehole Terminated @ 290 ft.			290.00						@ 290 ft. water production of 3.5 gal. in 10 min. Field parameters: PH: 7.95 Temp.: 29 C Salinity: 0.2% Conductivity: 890 umhos	
300												
310		NOTES: RC = 3.5" Rock Core. CSR = Center Sample Rotary/Reverse Circulation.										
320												

DRAFT

DRILL RIG: AP 1000
DRILLING CONTRACTOR: Dual Tube Inc.
DRILLER: Wesley Jamison

Golder Associates

LOGGED: RO
CHECKED: WGG
DATE: 4/14/90

PROJECT LOCATION: Ponce, P.R. | BORING DATE: 1/26/90 | DATUM: MSL

893-3803.2 | BORING LOCATION: See Remarks

SOIL PROFILE

DEPTH SCALE FEET	BORING METHOD	DESCRIPTION	USCS	ELEV / DEPTH
0	CSR	Fill- Soft, pale yellowish orange, moderately (mod.) weathered (weath.), fossiliferous (foss.) LIMESTONE-COBBLES (boulders to cobbles), some m-f sand, some clayey silt.	-	281.70 / 0.00
7		0.0' - 290.0' PONCE FORMATION: Very pale to dark yellowish orange, fossiliferous LIMESTONE Cobbles (10-80%), Gravel (10-70%), Sand (20-80%), Clayey Silt to Silty Clay (10-50%).		7.00
		Pale yellowish orange, fine SAND, some clayey silt, little c-f gravel, little to some limestone-cobbles.	SM-SC	
64		Soft, yellowish brown, SILTY CLAY, little m-f sand, trace fine gravel.	[illegible]	[illegible]
69		Pale yellowish orange, m-f SAND, some clayey silt, little fine gravel, little to some limestone-cobbles.	SM-SC	69.00
118		Soft to hard, pale yellowish orange, mod. weath., foss. LIMESTONE-COBBLES and m-f SAND, little to some clayey silt, little c-f gravel.	-	118.00
142		Soft, dark greenish gray, SILTY CLAY (weathered MUDSTONE), little fine sand.	-	142.00
148		Grayish orange to pale yellowish orange, m-f SAND, little to some clayey silt, little c-f gravel, little limestone-cobbles.	SM-SC	148.00

SAMPLES

NUMBER	TYPE	BLOWS / 6 in	N	REC/ATT
1	RC	-	-	80%
2	RC	-	-	100%
3	RC	-	-	100%
4	RC	-	-	100%
5	RC	-	-	100%
6	RC	-	-	100%
7	RC	-	-	100%
8	RC	-	-	100%
9	RC	-	-	100%
10	RC	-	-	100%
11	RC	-	-	100%
12	RC	-	-	100%
13	RC	-	-	100%
14	RC	-	-	100%
15	RC	-	-	100%
16	RC	-	-	100%

REMARKS

Ground elevation: 281.7 ft. (79.78 m.)
Location: N19,882.1 m.; E128,638.4 m.
Cavities from 0 to 7 ft.
Jar sample SA-1 taken at 8 ft.
SA-2 taken at 28 ft.
Moist from 40 to 64 ft.
SA-3 taken at 48 ft.
@ 55-60' hard zone.
SA-4 taken at 64 ft. Bag sample also collected.
SA-5 taken at 88 ft.
SA-6 taken at 108 ft.
SA-7 taken at 124 ft.
Wet from 131 to 132 ft.
SA-8 taken at 144 ft.
@ 147 ft. slickensided planar fracture, 90 degrees to core axis.
SA-9 taken at 149 ft.

PIEZOMETER OR STANDPIPE INSTALLATION

Volclay Grout

DRILL RIG: AP 1000
DRILLING CONTRACTOR: Dual Tube Inc.
DRILLER: Wesley Jamison

Golder Associates

LOGGED: RIO
CHECKED: WGG
DATE: 4/14/90

MONITORING WELL INSTALLATION LOG

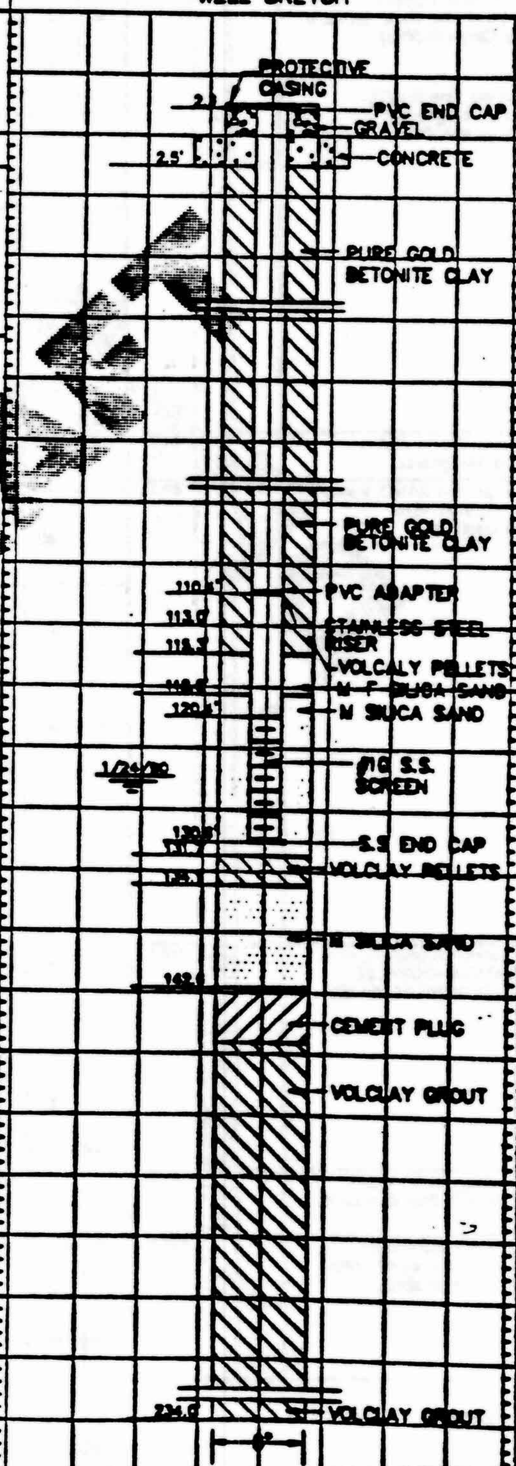
JOB NO. 893-3803.2 PROJECT BFI/RFA/PONCE WELL NO. GW-1 SHEET 1 of 1
GA INSP. RIO DRILLING METHOD CSR- CENTER SAMPLE ROTARY GROUND ELEV. [illegible] WATER DEPTH 125.7 FT.
WEATHER SUNNY DRILLING COMPANY DUAL TUBE DRILLING INC. COLLAR ELEV. [illegible] DATE/TIME 1/24/90 17:[illegible]
TEMP. 80's DRILL RIG AP 1000 DRILLER WESLEY JAMISON STARTED 13:00 1/23/90 (TIME / DATE) COMPLETED 16:00 1/27/[illegible] (TIME / DATE)
LOCATION / COORDINATES 19,700.03 N (M.), 128,165.50 E (M.)

MATERIALS INVENTORY

WELL CASING 1 7/8" I.D. in. dia. 110 l.f. WELL SCREEN 2" in. dia. 10' l.f. BENTONITE SEAL VOLCLAY PELLETS AND GRO[illegible]
CASING TYPE PVC SCHED. #80 SCREEN TYPE STAINLESS STEEL 316 INSTALLATION METHOD POURED-TREMIED
JOINT TYPE FLUSH JOINT-THREADED SLOT SIZE No. 10-0.010" FILTER PACK QTY. 16 GALLONS
GROUT QUANTITY 630 GALLONS CENTRALIZERS NONE FILTER PACK TYPE SILICA SAND
GROUT TYPE VOLCLAY PURE GOLD BENTONITE CLAY AND CEMENT DRILLING MUD TYPE N/A INSTALLATION METHOD TREMIED WITH WATE[illegible]

ELEV./DEPTH	SOIL/ROCK DESCRIPTION
	0.0–158.0' PONCE FORMATION
308.2	GROUND SURFACE
0.0	Soft, pale yellowish orange, moderately weathered, LIMESTONE (boulders to cobbles) and c-f GRAVEL, some fine sand, some clayey silt.
83.0	Dark, pale, and very pale, c-f SAND, some clayey silt, trace c-f gravel, trace limestone cobbles.
158.0	Stiff, dark greenish grey CLAYEY SILT, some c-f gravel, some limestone cobbles. (Juana Diaz Fm)
168.0	Soft, dark greenish grey unweathered limey MUDSTONE. (Juana Diaz Fm)
234.00	Borehole Terminated at 234'.

WELL SKETCH



INSTALLATION NOTES

1/23/90 TREMIED 90 GALS. OF VOLCLAY GROUT. TREMIED ~15 GAL[illegible] OF CEMENT GROUT, MEASURED AT 142.6'.
1/24/90 TREMIED ~16 GALS. OF MED. SAND. MEASURED A[illegible] 134.1'. TREMIED ~4 GALS VOLCLA[illegible] PELLETS. MEASURED AT 131.7'. TREMIED ~1 GAL. MED. SAND. INSTALLED BOTTOM OF SCREEN AT 130.6'. TREMIED ~16 GALS. OF MED. SAND. MEASURED AT 118.[illegible] TREMIED ~6 GALS. OF M-F SAND. MEASURED AT 115.3'. POURE[illegible] 3 GALS. OF VOLCLAY PELLETS. TO 113.0'. REMOVED DRILL PIPE.
2/21/90 GROUTED ~210 GALS. OF VOLCLAY GROUT AND 70 GALS. OF PURE GOLD BENTONITE CLAY GROU[illegible]
2/27/90 GROUTED ~245 GALS. OF PURE GOLD BENTONITE CLAY GROU[illegible] MEASURED AT ~3'. HIGH GROUT TA[illegible] LAST 10'. INSTALLED PROTECTIVE CASING.

WELL DEVELOPMENT NOTES

SEE WELL DEVELOPMENT FIELD RECORDS.

PROJECT: BFI/RFA/PONCE

PROJECT LOCATION: Ponce, P.R

PROJECT NUMBER: 893-3803.2

RECORD OF BOREHOLE GW-1

BORING DATE: 1/23/90

BORING LOCATION: See Remarks

DATUM: MSL

DEPTH SCALE FEET	BORING METHOD	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEV / DEPTH	SAMPLES: NUMBER	TYPE	BLOWS / 6 in	N	REC/ATT	REMARKS	PIEZOMETER OR STANDPIPE INSTALLATION
160	CSR		MH			17	RC	-	-	100%	Started using water @ 160 ft. for drilling.	
170		Soft, dark greenish gray, unweathered limey MUDSTONE. (Juana Diaz Formation)			168.00	18	RC	-	-	100%	SA-12 taken at 168 ft. @ 169' and 178' slickensided planar fractures with calcite infilling. 70 degrees to core axis. Water sample taken 170'-190' Field parameters: PH: 7.8 Temp.: 26.2 C Spec. Cond.: 800 umhos	
180						19	RC	-	-	100%	SA-13 taken at 188 ft.	
190						20	RC	-	-	90%	@ 192 ft. slickensided planar fracture 90 deg. to core axis.	Volclay Grout
200						21	RC	-	-	100%	@ 199', 201', 202' slickensided fractures along core axis.	
210						22	RC	-	-	100%		
220						23	RC	-	-	100%		
230						24	RC	-	-	100%		
240		Borehole Terminated @ 234 ft.			234.00							
250		NOTES: RC = 3.5" Rock Core. CSR = Center Sample Rotary/Reverse Circulation.										
260												
270												
280												
290												
300												
310												
320												

DRILL RIG: AP 1000

DRILLING CONTRACTOR: Dual Tube Inc.

DRILLER: Wesley Jamison

Golder Associates

LOGGED: RIO

CHECKED: WGG

DATE: 4/15/90

PROJECT LOCATION: Ponce, P.R

PROJECT NUMBER: 8?3-3803.2

BORING DATE: 1/23/90

BORING LOCATION: See Remarks

DATUM: MSL

SOIL PROFILE

DEPTH SCALE FEET	BORING METHOD	DESCRIPTION	USCS	GRAPHIC LOG	ELEV / DEPTH
0	CSR				308.20
0–26	CSR	0.0' - 158.0' PONCE FORMATION: Very pale to dark yellowish orange fossiliferous LIMESTONE Cobbles (10-80%), Gravel (10-70%), Sand (20-60%), Clayey Silt to Silty Clay (10-50%). Soft, pale yellowish orange, moderately (mod.) weatherd (weath.), LIMESTONE-COBBLES and c-f GRAVEL, some fine sand, some clayey silt.			0.00
26–52	CSR	Pale yellowish orange, c-f LIMESTONE GRAVEL and fine SAND, some clayey silt, occasional limestone cobbles.	GM-GC		26.00
52–56	CSR	Soft, pale yellowish orange, mod. weath. LIMESTONE-COBBLES and c-f GRAVEL, some fine sand, some clayey silt.			52.00
56–83	CSR	Dark to pale yellowish orange, c-f GRAVEL, some fine sand, some clayey silt.	GM-GC		56.00
83–98	CSR	Pale to very pale yellowish orange, c-f SAND, some clayey silt, trace c-f gravel, trace limestone-cobbles.	SM-SC		83.00
98–125	CSR	Dark to pale yellowish orange, c-f SAND, some clayey silt, little c-f gravel, little limestone cobbles.	SM-SC		98.00
125–139	CSR	Pale to very pale yellowish orange, c-f SAND, some clayey silt, trace c-f gravel, trace limestone-cobbles.	SM-SC		125.00
139–158	CSR	Pale yellowish orange c-f SAND and SILTY CLAY, some c-f gravel, some limestone-cobbles.	SM-SC		139.00
158–	CSR	Stiff, dark greenish gray, CLAYEY SILT, trace to little fine sand. (Juana Diaz Formation)			158.00

SAMPLES

NUMBER	TYPE	BLOWS / 6 in	N	REC/ATT
1	RC	-	-	100%
2	RC	-	-	100%
3	RC	-	-	100%
4	RC	-	-	100%
5	RC	-	-	100%
6	RC	-	-	100%
7	RC	-	-	80%
8	RC	-	-	100%
9	RC	-	-	100%
10	RC	-	-	100%
11	RC	-	-	100%
12	RC	-	-	100%
13	RC	-	-	100%
14	RC	-	-	100%
15	RC	-	-	100%
16	RC	-	-	100%

REMARKS

Ground elevation: 308.2 ft. (93.95 m.)
Location:
N19,700.0 m.;E128,165.5 m.
Jar sample SA-1 taken at 8 ft.
SA-2 taken at 18 ft.
SA-3 taken at 28 ft.
SA-4 taken at 58 ft.
SA-5 taken at 68 ft.
SA-6 taken at 78 ft.
SA-7 taken at 88 ft.
SA-8 taken at 98 ft.
@ 105 ft. soil is moist.
SA-9 taken at 118 ft.
Wet from 130 to 132 ft.
Dry @ 133 ft.
SA-10 taken at 139 ft.
Moist from 140 to 146 ft.
Dry @ 146 ft.
SA-11 taken at 156 ft.

PIEZOMETER OR STANDPIPE INSTALLATION

Bentonite Grout

Filter Sand

122.7'
1/24/90

Volclay Pellets

Sand

DRILL RIG: AP 1000

DRILLING CONTRACTOR: Dual Tube Inc.

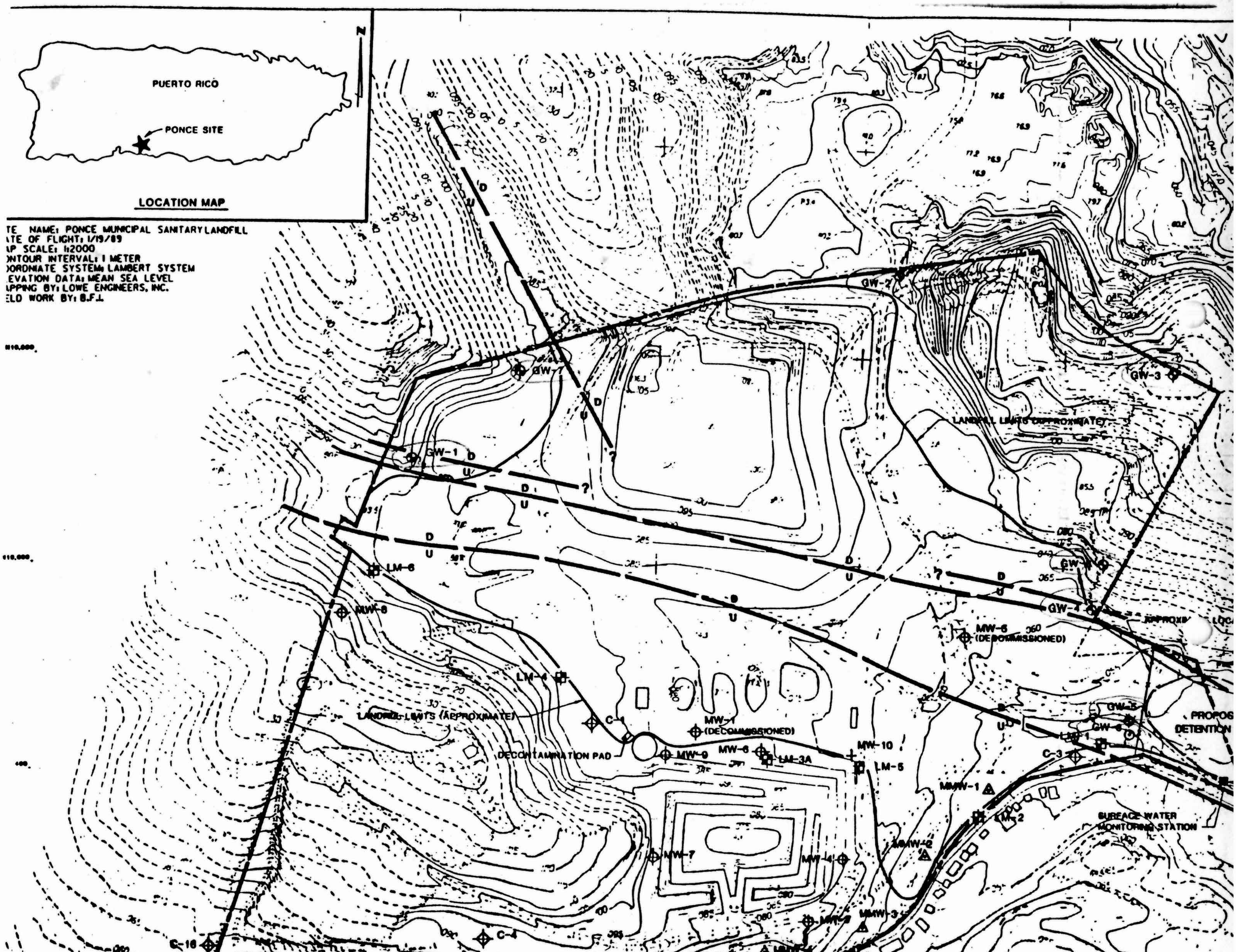
DRILLER: Wesley Jameson

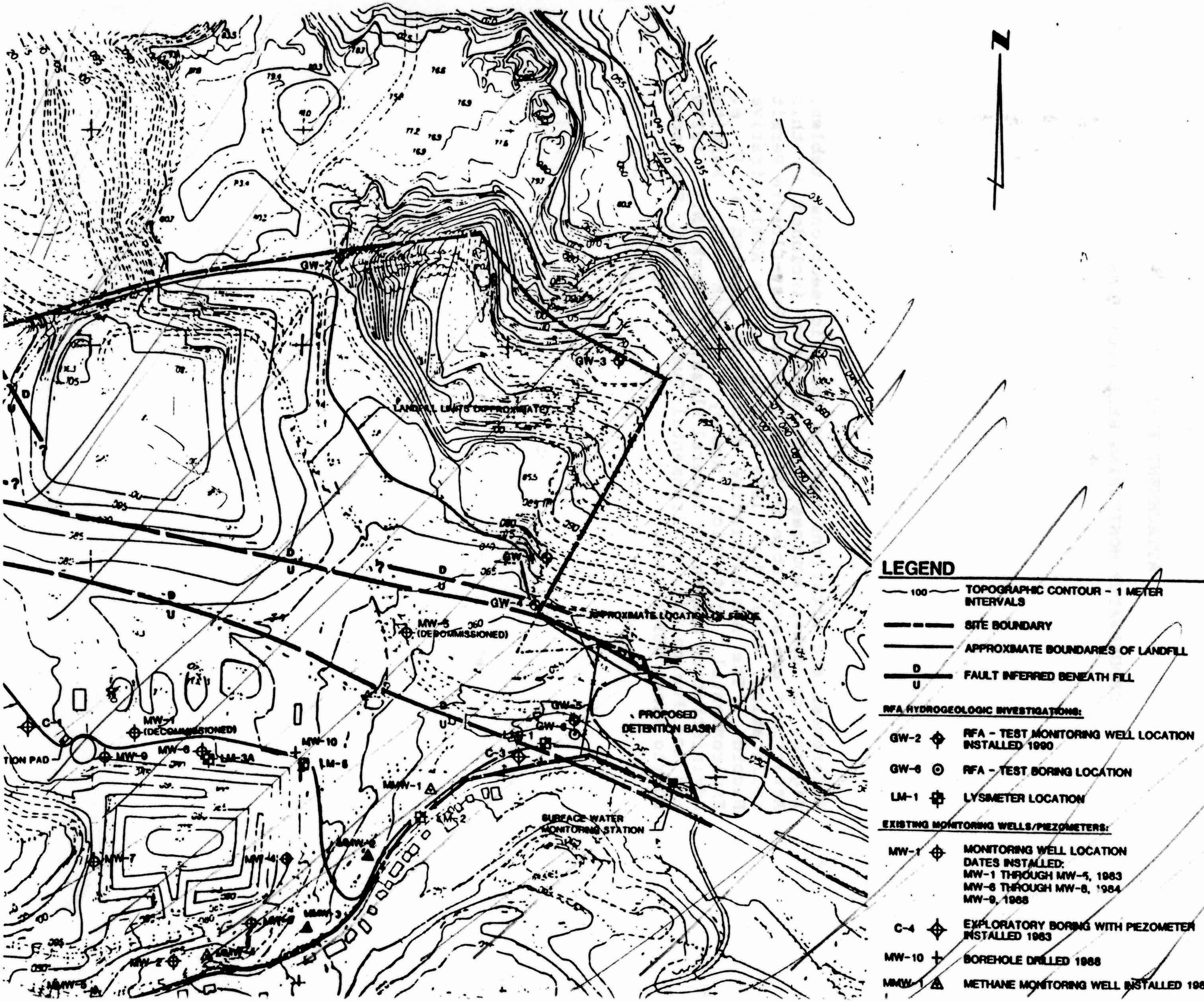
LOGGED: RC

CHECKED: WGG

DATE: 4/13/90

Golder Associates


PUERTO RICO
PONCE SITE
LOCATION MAP
TE NAME: PONCE MUNICIPAL SANITARY LANDFILL
ATE OF FLIGHT: 1/19/89
AP SCALE: 1:2000
ONTOUR INTERVAL: 1 METER
OORDINATE SYSTEM: LAMBERT SYSTEM
LEVATION DATA: MEAN SEA LEVEL
APPING BY: LOWE ENGINEERS, INC.
ELD WORK BY: B.F.I.
GW-1
GW-2
GW-3
GW-4
GW-5
GW-6
GW-7
LANDFILL LIMITS (APPROXIMATE)
LM-4
LM-5
LM-6
LM-3A
MW-1 (DECOMMISSIONED)
MW-6 (DECOMMISSIONED)
MW-6
MW-7
MW-8
MW-9
MW-10
MMW-1
MMW-2
MMW-3
C-1
C-3
C-4
C-16
DECONTAMINATION PAD
SURFACE WATER MONITORING STATION
PROPOS
DETENTION


N
LANDFILL LIMITS (APPROXIMATE)
GW-2
GW-3
GW-4
GW-5
GW-6
MW-5 (DECOMMISSIONED)
MW-1 (DECOMMISSIONED)
MW-9
MW-6
LM-3A
MW-10
LM-6
C-4
C-3
MMW-1
LM-2
MW-7
MW-2
MW-4
PROPOSED DETENTION BASIN
SURFACE WATER MONITORING STATION
APPROXIMATE LOCATION OF FENCE
LEGEND
TOPOGRAPHIC CONTOUR - 1 METER INTERVALS
SITE BOUNDARY
APPROXIMATE BOUNDARIES OF LANDFILL
FAULT INFERRED BENEATH FILL
RFA HYDROGEOLOGIC INVESTIGATIONS:
GW-2 RFA - TEST MONITORING WELL LOCATION INSTALLED 1990
GW-6 RFA - TEST BORING LOCATION
LM-1 LYSIMETER LOCATION
EXISTING MONITORING WELLS/PIEZOMETERS:
MW-1 MONITORING WELL LOCATION
DATES INSTALLED:
MW-1 THROUGH MW-5, 1983
MW-6 THROUGH MW-8, 1984
MW-9, 1988
C-4 EXPLORATORY BORING WITH PIEZOMETER INSTALLED 1983
MW-10 BOREHOLE DRILLED 1988
MMW-1 METHANE MONITORING WELL INSTALLED 1988

ATTACHMENT IV-1

GROUNDWATER MONITORING WELL LOCATIONS

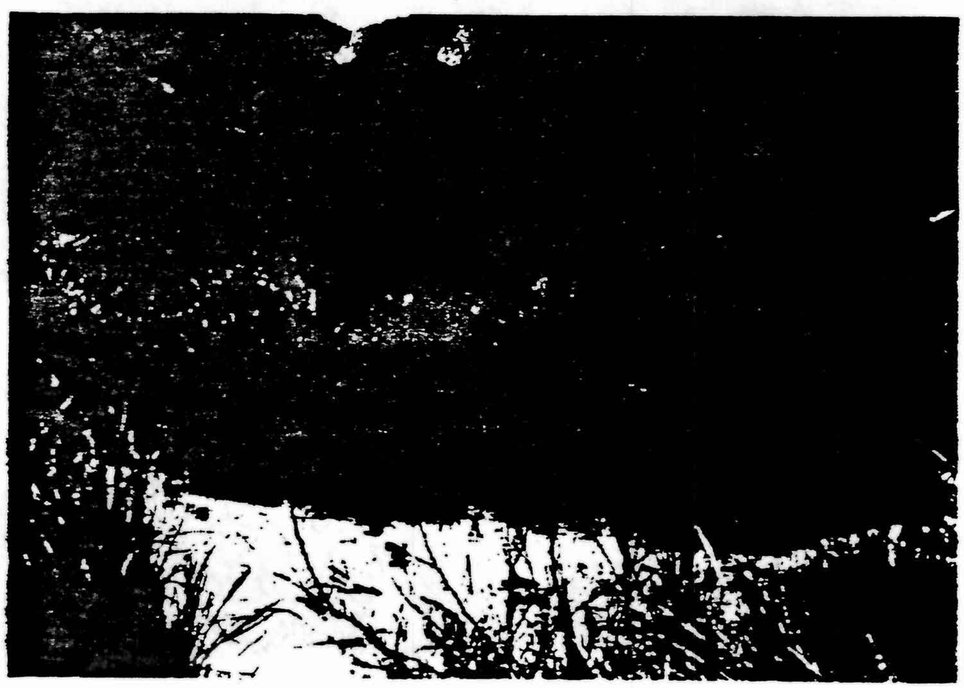
* References and citations made to specific sections, tables, figures or other sources which are not included in this Attachment are available in BFI's revised Post-Closure Permit application, dated May, 1989 and is in the Administrative Record. The Administrative Record is located at U. S. Environmental Protection Agency, Region II, Permits Administration Branch, 26 Federal Plaza, New York, N.Y., 10278 and the Puerto Rico Environmental Quality Board, Santurce, Puerto Rico, 00910-1488.

Landfill and Environs

Road into Landfill

Active Landfill Area

Landfill Site Conditions



Landfill Boundary

APPENDIX C

PHOTOS TAKEN
DURING VSI
ON
JULY 17, 1986

(continued)
SUMMARY OF SK & F SAMPLE COMPOSITE ANALYSIS

PARAMETER	UNIT OF MEASURE	SAMPLE IDENTIFICATION PARAMETER				
		Comp-14	Comp-15	Comp-16	CM-AM-1	CM-AM-2
pH w/water	STANDARD UNIT	7.04	11.31	9.10	9.76	10.58
Leachable TOC	mg/l	27	207	64	11,800	10,900
Sulfide	ug/g Dry	112	180.3	306.2	125	134
T-Cyanide	ug/g Dry	3.66	8.44	3.70	<0.5	<0.5
T-Chromium	ug/g Dry	28	35	15	23.9	25.7
T-Copper	ug/g Dry	19	28	7.6	7.48	8.50
T-Lead	ug/g Dry	2.6	7.5	3.0	380	130
T-Nickel	ug/g Dry	20	24	4.5	4.27	9.23
T-Silver	ug/g Dry	<0.3	1.5	<0.2	<0.3	<0.2
T-Zinc	ug/g Dry	120	59	7.0	10.5	13.4
T-Iron	ug/g Dry	22,200	19,200	8,900	21,300	19,500
Halogenated Organic Scan (ECD)	ug/g Dry as Chlorine; Lindane Std.	0.15	1.2	0.01	0.04	0.03
Dry Weight	%	75	71	81	96	97

(continued)
SUMMARY OF SK & F SAMPLE COMPOSITE ANALYSIS

PARAMETER	UNIT OF MEASURE	SAMPLE IDENTIFICATION PARAMETER							
		Comp-6	Comp-7	Comp-8	Comp-9	Comp-10	Comp-11	Comp-12	Comp-13
pH w/water	STANDARD UNIT	8.08	8.48	>12.00	12.02	10.68	8.42	9.37	9.07
Leachable TOC	mg/l	45	44	100	96	27	33	132	31
Sulfide	ug/g Dry	136.7	220.0	406.5	194.7	101.2	96.6	610.0	<22.2
T-Cyanide	ug/g Dry	6.64	0.78	0.81	1.22	0.48	1.06	2.03	3.47
T-Chromium	ug/g Dry	30	29	40	55	19	29	20	18
T-Copper	ug/g Dry	24	18	66	46	5.9	11	9.2	6.4
T-Lead	ug/g Dry	1.7	1.8	25	8.3	1.2	1.9	1.1	0.77
T-Nickel	ug/g Dry	36	24	34	20	5.1	11	16	4.1
T-Silver	ug/g Dry	>0.03	<0.3	<0.4	<0.4	<0.2	<0.2	<0.3	<0.2
T-Zinc	ug/g Dry	76	63	180	94	3.7	36	14	6.0
T-Iron	ug/g Dry	21,100	12,600	98,400	7,800	8,700	8,900	10,000	4,800
Halogenated Organic Scan (ECD)	ug/g Dry as Chlorine; Lindane Std.	0.13	0.02	0.11	1.4		0.07		0.17
Dry Weight	%	79	80	62	76	83	87	80	90

SUMMARY OF SK & F SAMPLE COMPOSITE ANALYSIS

PARAMETER	UNIT OF MEASURE	SAMPLE IDENTIFICATION PARAMETER				
		Comp-1	Comp-2	Comp-3	Comp-4	Comp-5
pH with water	STANDARD UNIT	9.75	8.12	7.87	7.85	7.79
Leachable TOC	mg/l	30	63	26	74	28
Sulfide	ug/g Dry	127.5	13.1	371.1	194.7	85
T-Cyanide	ug/g Dry	5.89	7.58	3.37	2.47	4.62
T-Chromium	ug/g Dry	29	41	26	30	31
T-Copper	ug/g Dry	28	30	18	23	18
T-Lead	ug/g Dry	7.7	110	39	19	1.8
T-Nickel	ug/g Dry	16	26	22	21	22
T-Silver	ug/g Dry	0.73	<0.4	<0.4	<0.4	<0.4
T-Zinc	ug/g Dry	65	84	77	180	47
T-Iron	ug/g Dry	18,600	64,400	15,700	18,600	17,700
Halogenated Organic Scan (ECD)	ug/g Dry as Chlorine; Lindane Std.	<0.01	0.24	<0.01	0.07	0.09
Dry Weight	%	70	61	83	76	80

SUMMARY ANALYTICAL RESULTS FOR CO-DISPOSAL AREA CONPOSITES

Parameter	Unit of Measure	SAMPLE IDENTIFICATION											
		COMP-CD-2	COMP-CD-4	COMP-CD-6	COMP-CD-8	COMP-CD-9	COMP-CD-10	COMP-CD-11	COMP-CD-12	COMP-CD-13	COMP-CD-14	COMP-CD-15	COMP-CD-16
Chemical Oxygen Demand	g/g Dry	5,700	7,800	9,000	21,500	55,300	27,100	53,300	11,700	163,000	12,800	24,700	4,010
Total Recoverable Phenolics	g/g Dry	2.27	2.03		0.82			1.15	2.09	2.89			
Total Recoverable Oil & Grease	g/gDry	2,280	330	1,400	21,000	3,300	2,280	7,090	1,740	8,330	33,700	18,800	54,400
Total Cyanide	g/g Dry		0.76	0.72	1.97	2.28				0.93	0.77	1.43	1.22
Total Barium	g/g Dry	76	110	204	228	120	133	244	153	113	45		250
Total Zinc	g/g Dry	34	204	24	46	149	50	72	84	52	24	42	4.7
Halogenated Organic Scan (ECD)	*		0.76		0.10	0.10				0.23			
Total Polychlorinated Biphenyls	**		0.17 0.34 0.41										

* ug/g dry as Chlorine; Lindane Standard

** ug/g dry as Aroclor 1242
ug/g dry as Aroclor 1260
ug/g dry Total

APPENDIX B

CHEMICAL ANALYSIS
OF COMPOSITE SAMPLE
FROM THE SOIL BORINGS
IN THE
CO-DISPOSAL AREA
AND SK & F IMPOUNDMENT AREA

Source: Report of Investigations on Co–disposal Area and Closure Activities Associated with S K & F Surface Impoundment Area, by RECREA Research, Inc., May, 1984. (Reference 13)

PARAMETER	UNITS OF MEASURE	MW-5* SAMPLING DATES 8/83	11/83	1/84	2/84	3/84	MW-6* SAMPLING DATES 8/83	11/83	1/84	2/84	3/84	MW-7* SAMPLING DATES 8/83	11/83	1/84	2/84	3/84	MW-8* SAMPLING DATES 8/83	11/83	1/84	2/84	3/84
Bromodichloro-methane	ug/l		ND	ND		ND				ND				ND	ND	ND					ND
Chloroform	ug/l		ND	ND		ND				ND				ND	ND	ND					ND
Aldrin	ug/l		0.05	<0.1		<0.01				<0.01				<0.01	<0.01	<0.01					<0.01
BHC	ug/l		0.03	<0.1		<0.01				<0.01				<0.01	<0.01	<0.01					<0.01
BHC	ug/l		0.37	<0.1		<0.01				<0.01				<0.01	<0.01	<0.01					<0.01
BHC	ug/l		0.17	31		<0.01				<0.01				2.3	<0.01	<0.01					<0.01
BHC	ug/l		0.08	<0.1		<0.01				<0.01				<0.01	<0.01	<0.01					<0.01
4,4'-DDE	ug/l		<0.02	<0.1		<0.01				<0.01				<0.01	<0.01	<0.01					<0.01
Dieldrin	ug/l		0.59	<0.1		<0.01				<0.01				<0.01	<0.01	<0.01					<0.01
Endosulfan	ug/l		0.11	<0.1		<0.01				<0.01				0.05	<0.01	<0.01					<0.01
Heptachlor	ug/l		<0.02	<0.1		<0.01				<0.01				0.01	<0.01	<0.01					<0.01
Heptachlor Epoxide	ug/l		<0.02	<0.1		<0.01				<0.01				0.01	<0.01	<0.01					<0.01
Trans-1,2-dichloro-methylene	ug/l		22	22		25				ND				ND	ND	ND					ND
T-Arsenic	mg/l		N/A	N/A		N/A				N/A				N/A	N/A	N/A					N/A
T-Cadmium	mg/l		N/A	N/A		N/A				N/A				N/A	N/A	N/A					N/A
T-Chromium	mg/l		N/A	N/A		N/A				N/A				N/A	N/A	N/A					N/A
T-Copper	mg/l		N/A	N/A		N/A				N/A				N/A	N/A	N/A					N/A
T-Lead	mg/l		N/A	N/A		N/A				N/A				N/A	N/A	N/A					N/A
T-Nickel	mg/l		N/A	N/A		N/A				N/A				N/A	N/A	N/A					N/A
T-Selenium	mg/l		N/A	N/A		N/A				N/A				N/A	N/A	N/A					N/A
T-Silver	mg/l		N/A	N/A		N/A				N/A				N/A	N/A	N/A					N/A
T-Thallium	mg/l		N/A	N/A		N/A				N/A				N/A	N/A	N/A					N/A
T-Zinc	mg/l		N/A	N/A		N/A				N/A				N/A	N/A	N/A					N/A
T-Calcium	mg/l		N/A	N/A		N/A				N/A				N/A	N/A	N/A					N/A
T-Magnesium	mg/l		N/A	N/A		N/A				N/A				N/A	N/A	N/A					N/A
T-Sodium	mg/l		N/A	N/A		N/A				N/A				N/A	N/A	N/A					N/A
T-Potassium	mg/l		N/A	N/A		N/A				N/A				N/A	N/A	N/A					N/A
T-Iron	mg/l		N/A	N/A		N/A				N/A				N/A	N/A	N/A					N/A
T-Barium	mg/l		N/A	N/A		N/A				N/A				N/A	N/A	N/A					N/A
T-Manganese	mg/l		N/A	N/A		N/A				N/A				N/A	N/A	N/A					N/A
T-Soluble Aluminum	mg/l		0.22	<0.2		0.45				9.7				<0.2	0.7	<0.41					0.35
T-Soluble Barium	mg/l		0.59	1.46		0.50				1.45				0.39	0.54	0.74					0.11
T-Soluble Calcium	mg/l		819	1,040		1,430				411				67.3	272	895					450
T-Soluble Iron	mg/l		1.2	<0.03		1.1				28.0				<0.03	9.3	4.1					<0.04
T-Soluble Lead	mg/l		<0.002	<0.002		0.11				0.006				<0.002	<0.002	0.03					0.04
T-Soluble Magnesium	mg/l		840	530		650				228				170	163	100					26
T-Soluble Manganese	mg/l		2.3	2.6		6.1				0.73				0.01	1.12	1.6					0.02
T-Soluble Molybdenum	mg/l		<0.08	<0.08		<0.2				<0.08				<0.08	<0.08	<0.2					<0.2
T-Soluble Potassium	mg/l		141	136		190				24.4				40	58.0	57					21
T-Soluble Sodium	mg/l		4,650	3,500		4,600				980				640	1,170	87					94
T-Soluble Vanadium	mg/l		5.8	5.6		<0.12				<0.1				0.54	<0.1	<0.12					<0.12
T-Soluble Arsenic	mg/l		<0.005	<0.005		<0.005				0.011				<0.005	<0.005	<0.005					<0.005
T-Soluble Cadmium	mg/l		0.039	<0.007		<0.007				<0.02				<0.007	<0.02	<0.007					<0.007
T-Soluble Chromium	mg/l		0.014	0.004		<0.008				0.042				<0.004	0.011	<0.008					0.02
T-Soluble Selenium	mg/l		<0.005	<0.005		<0.005				0.006				<0.005	<0.005	<0.005					<0.005
T-Soluble Silver	mg/l		<0.008	0.023		<0.009				0.032				<0.005	<0.01	<0.009					<0.009
T-Soluble Antimony	mg/l		0.033	<0.01		0.007				<0.01				<0.01	0.010	<0.005					0.005
T-Soluble Beryllium	mg/l		0.008	<0.006		<0.006				<0.004				<0.006	<0.004	<0.006					<0.006
T-Soluble Copper	mg/l		0.056	0.064		0.03				0.114				0.006	0.015	0.02					0.01
T-Soluble Nickel	mg/l		0.089	0.139		0.30				0.057				<0.005	0.009	0.016					<0.005
T-Soluble Thallium	mg/l		0.028	<0.01		0.006				<0.01				<0.01	<0.01	<0.005					<0.02
T-Soluble Zinc	mg/l		0.238	0.394		0.11				0.786				0.2	1.75	0.03					0.02
Chloride	mg/l		8,000	8,510		8,560				1,690				892	1,420	1,590					1,100
Sulfate	mg/l		145	1,860		1,430				680				[illegible]	960	835					450
Bicarbonate Alkalinity	mg/l as $CaCO_3$		N/A	N/A		2,350				N/A				N/A	N/A	450					117
Fluoride	mg/l		0.84	0.64		0.62				0.18				0.13	0.19	0.30					0.50
Total Recoverable Phenolic	mg/l		<0.01	0.029		0.01				<0.01				0.026	0.016	<0.01					<0.01
Total Organic Carbon	mg/l		86	78		94				74.5				3.0	7.0	3.0					4.0
Total Organic Halide	ug/l		58	1,600		903				74.0				200	11.0	29					23
Total Alpha Radiation	pCi/l		21±20	[illegible]		[illegible]				14±12				[illegible]	19±11	[illegible]					12±10
Gross Beta Radiation	pCi/l		[illegible]	73±9		[illegible]				38±7				19±7	17±3	14±3					9±3
Total Radium	pCi/l		[illegible]	1		[illegible]				14±2				3±2	1	1					1

PARAMETER	UNITS OF MEASURE	MW-1* SAMPLING DATES 8/83	11/83	1/84	2/84	3/84	MW-2 SAMPLING DATES 8/83	11/83	1/84	2/84	3/84	MW-3 SAMPLING DATES 8/83	11/83	1/84	2/84	3/84	MW-4 SAMPLING DATES 8/83	11/83	1/84	2/84	3/84
Bromodichloromethane	ug/l	3.5					-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chloroform	ug/l	17					-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Aldrin	ug/l	-					-	0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	<0.01	-	0.01	<0.01	<0.01	<0.01
BHC	ug/l	-					-	<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	<0.01
BHC	ug/l	-					-	<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	<0.01
BHC	ug/l	-					-	0.44	0.11	<0.01	<0.01	-	0.03	0.16	<0.01	<0.01	-	<0.01	0.12	<0.01	<0.01
BHC	ug/l	-					-	0.04	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	<0.01
4,4'-DDE	ug/l	-					-	0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	<0.01	-	0.01	<0.01	<0.01	<0.01
Dieldrin	ug/l	-					-	<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	<0.01	-	<0.01	0.07	<0.01	<0.01
Endosulfan	ug/l	-					-	0.08	<0.01	<0.01	<0.01	-	<0.01	0.06	<0.01	<0.01	-	0.99	0.03	<0.01	<0.01
Heptachlor	ug/l	-					-	0.01	<0.01	<0.01	<0.01	-	0.02	<0.01	<0.01	<0.01	-	2.5	<0.01	<0.01	<0.01
Heptachlor Epoxide	ug/l	-					-	<0.01	<0.01	<0.01		-	<0.01	<0.01	<0.01		-	0.09	<0.01	<0.01	
Trans-1,2-dichloroethylene	ug/l	-					-	ND	ND	ND	ND	-	ND	ND	ND	ND	-	ND	ND	ND	ND
t-Arsenic	mg/l	0.010					<0.005	N/A	N/A	N/A	N/A	0.007	N/A	N/A	N/A	N/A	0.007	N/A	N/A	N/A	N/A
t-Cadmium	mg/l	<0.004					<0.004	N/A	N/A	N/A	N/A	0.004	N/A	N/A	N/A	N/A	0.006	N/A	N/A	N/A	N/A
t-Chromium	mg/l	0.040					0.010	N/A	N/A	N/A	N/A	0.018	N/A	N/A	N/A	N/A	0.015	N/A	N/A	N/A	N/A
t-Copper	mg/l	0.080					0.081	N/A	N/A	N/A	N/A	0.032	N/A	N/A	N/A	N/A	0.032	N/A	N/A	N/A	N/A
t-Lead	mg/l	0.020					0.019	N/A	N/A	N/A	N/A	<0.005	N/A	N/A	N/A	N/A	<0.005	N/A	N/A	N/A	N/A
t-Nickel	mg/l	0.017					0.008	N/A	N/A	N/A	N/A	0.102	N/A	N/A	N/A	N/A	0.033	N/A	N/A	N/A	N/A
t-Selenium	mg/l	<0.005					0.022	N/A	N/A	N/A	N/A	0.011	N/A	N/A	N/A	N/A	<0.005	N/A	N/A	N/A	N/A
t-Silver	mg/l	0.007					<0.005	N/A	N/A	N/A	N/A	<0.005	N/A	N/A	N/A	N/A	0.006	N/A	N/A	N/A	N/A
t-Thallium	mg/l	<0.005					<0.005	N/A	N/A	N/A	N/A	<0.005	N/A	N/A	N/A	N/A	0.006	N/A	N/A	N/A	N/A
t-Zinc	mg/l	0.236					0.146	N/A	N/A	N/A	N/A	0.198	N/A	N/A	N/A	N/A	0.278	N/A	N/A	N/A	N/A
t-Calcium	mg/l	220					370	N/A	N/A	N/A	N/A	1,100	N/A	N/A	N/A	N/A	1,300	N/A	N/A	N/A	N/A
t-Magnesium	mg/l	95					320	N/A	N/A	N/A	N/A	670	N/A	N/A	N/A	N/A	590	N/A	N/A	N/A	N/A
t-Sodium	mg/l	280					1,000	N/A	N/A	N/A	N/A	2,500	N/A	N/A	N/A	N/A	2,800	N/A	N/A	N/A	N/A
t-Potassium	mg/l	10					10	N/A	N/A	N/A	N/A	44	N/A	N/A	N/A	N/A	56	N/A	N/A	N/A	N/A
t-Iron	mg/l	33					21	N/A	N/A	N/A	N/A	20	N/A	N/A	N/A	N/A	74	N/A	N/A	N/A	N/A
t-Barium	mg/l	0.07					0.15	N/A	N/A	N/A	N/A	<0.03	N/A	N/A	N/A	N/A	<0.03	N/A	N/A	N/A	N/A
t-Manganese	mg/l	0.57					0.50	N/A	N/A	N/A	N/A	1.1	N/A	N/A	N/A	N/A	0.51	N/A	N/A	N/A	N/A
t-Soluble Aluminum	mg/l	N/A					N/A	0.35	<0.2	7.2	0.41	N/A	0.25	<0.2	2.3	0.33	N/A	<0.06	<0.2	2.4	0.59
t-Soluble Barium	mg/l	N/A					N/A	0.017	1.29	0.70	0.17	N/A	0.35	0.55	1.90	0.14	N/A	0.36	0.59	2.4	<0.03
t-Soluble Calcium	mg/l	N/A					N/A	391	452	305	200	N/A	571	798	750	1,880	N/A	556	971	821	1,380
t-Soluble Iron	mg/l	N/A					N/A	0.55	0.27	19.2	<0.004	N/A	1.8	0.40	3.30	0.74	N/A	0.12	<0.03	6.20	2.1
t-Soluble Lead	mg/l	N/A					N/A	<0.002	<0.002	0.006	0.02	N/A	<0.002	<0.002	<0.002	0.01	N/A	<0.002	<0.002	0.011	0.02
t-Soluble Magnesium	mg/l	N/A					N/A	560	235	193	190	N/A	855	740	935	1,200	N/A	735	530	880	850
t-Soluble Manganese	mg/l	N/A					N/A	0.02	<0.01	0.49	0.04	N/A	0.23	0.23	0.26	0.14	N/A	0.04	0.17	0.24	0.51
t-Soluble Molybdenum	mg/l	N/A					N/A	0.23	<0.08	<0.08	<0.2	N/A	<0.08	<0.08	<0.08	<0.2	N/A	0.08	<0.08	<0.08	<0.2
t-Soluble Potassium	mg/l	N/A					N/A	13	14	13.5	11	N/A	50	61	75	68	N/A	30	62	73	73
t-Soluble Sodium	mg/l	N/A					N/A	1,150	1,030	1,300	770	N/A	1,740	1,510	1,920	1,400	N/A	980	1,050	1,330	1,0[illegible]
t-Soluble Vanadium	mg/l	N/A					N/A	2.8	2.2	<0.10	<0.12	N/A	4.1	3.6	<0.10	<0.12	N/A	3.7	4.1	<0.1	<0.12
t-Soluble Arsenic	mg/l	N/A					N/A	0.046	0.010	<0.005	<0.005	N/A	0.074	<0.005	0.006	<0.005	N/A	<0.005	<0.005	<0.008	<0.005
t-Soluble Cadmium	mg/l	N/A					N/A	0.018	<0.007	<0.02	<0.007	N/A	0.029	0.014	<0.02	<0.007	N/A	0.020	<0.007	<0.02	<0.007
t-Soluble Chromium	mg/l	N/A					N/A	<0.006	<0.004	0.027	<0.008	N/A	0.008	<0.004	0.078	<0.008	N/A	0.008	0.014	0.021	<0.008
t-Soluble Selenium	mg/l	N/A					N/A	0.248	0.356	0.186	0.05	N/A	0.069	0.098	0.034	0.008	N/A	0.053	0.066	0.042	0.07
t-Soluble Silver	mg/l	N/A					N/A	0.009	<0.005	0.207	<0.009	N/A	<0.008	0.008	0.040	<0.009	N/A	<0.008	0.007	0.047	<0.009
t-Soluble Antimony	mg/l	N/A					N/A	0.033	<0.01	<0.01	0.005	N/A	0.028	<0.01	0.023	0.009	N/A	0.013	<0.010	0.044	0.006
t-Soluble Beryllium	mg/l	N/A					N/A	<0.007	<0.006	<0.008	<0.006	N/A	<0.007	<0.006	<0.004	<0.006	N/A	<0.007	<0.006	<0.004	<0.006
t-Soluble Copper	mg/l	N/A					N/A	<0.01	0.044	0.106	0.02	N/A	<0.01	0.068	0.037	<0.009	N/A	<0.01	0.110	0.054	0.02
t-Soluble Nickel	mg/l	N/A					N/A	0.035	0.037	0.010	0.01	N/A	0.042	0.041	0.032	0.04	N/A	0.009	0.024	0.015	0.03
t-Soluble Thallium	mg/l	N/A					N/A	0.012	<0.01	<0.01	<0.005	N/A	0.021	<0.01	0.013	<0.005	N/A	0.019	<0.01	0.014	<0.005
t-Soluble Zinc	mg/l	N/A					N/A	0.027	0.254	0.193	0.14	N/A	0.182	0.679	0.129	0.11	N/A	0.027	0.676	0.131	0.22
Chloride	mg/l	750					1,940	1,940	1,840	1,620	1,650	3,620	3,860	4,030	3,950	3,830	3,200	3,320	3,620	3,670	3,760
Sulfate	mg/l	310					480	1,760	1,540	500	210	2,060	1,890	2,350	2,020	1,880	1,350	841	1,560	1,400	1,380
Bicarbonate Alkalinity	mg/l as $CaCO_3$	2,800					940	N/A	N/A	N/A	101	520	N/A	N/A	N/A	484	520	N/A	N/A	N/A	520
Fluoride	mg/l							1.56	1.16	1.2	1.26		0.33	0.47	0.31	0.27		0.34	0.39	0.25	0.22
Total Recoverable Phenolic	mg/l	<0.01					<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.029	<0.01	<0.01	<0.01	<0.01	<0.01	0.015	<0.01
Total Organic Carbon	mg/l	N/A					N/A	2.9	7.8	41	9.0	N/A	22	4.0	33	5.5	N/A	6.5	5.0	31	2.2
Total Organic Halide	ug/l	N/A					N/A	87	89	53	22	N/A	140	2,600	66	22	N/A	90	2,025	83	104
Gross Alpha Radiation	pCi/l	N/A					N/A	6±5	<2	10±12	2	N/A	9±8	<2	5±4	<2	N/A	5±4	4±2	<2	<2
Gross Beta Radiation	pCi/l	N/A					N/A	13±3	18±7	26±6	9±3	N/A	15±3	28±8	16±3	13±3	N/A	17±3	30±8	15±3	18±3
Total Radium	pCi/l	N/A					N/A	7±2	<1	5±1	<1	N/A	<1	<1	2±1	2±1	N/A	<1	4±2	<1	<1

* ... See ... for explanation   N/D - None detected

CORE HOLE LOCATION	BORING BEGAN	COMPLETED	BOREHOLE ORIENTATION DIP
METHOD OF [illegible]ING	DRILLING	GR.ELEV. / [illegible]EATHER	AZIMUTH
CASING USED / SIZE	MUD USED	INSPECT. / [illegible]ERAT.	WATER LEVEL,TIME,DATE

LENGTH	RUN NUMBER	BOX NUMBER	RECOVERY	RQD	DISCONTINUITIES					LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES-LABORATORY TESTS
					TYPE	INFILLING	INCLINATION	ORIENTATION	FRACTURES/FT.								

NOTES:

DATE LOGGED BY

FIGURE C-1 FIELD COREHOLE LOG

FIGURE C-2 BASIC DRILL HOLE DATA

PROJECT:	BOREHOLE NO:
LOCATION:	
CLIENT:	
DRILLING CONTRACTOR:	
DRILLING METHOD:	MACHINE:
CORE BARREL & BIT DESIGN:	ORIENTATION OF HOLE:
DATUM:	ELEVATION OF COLLAR:
OVERBURDEN THICKNESS:	DATE HOLE STARTED:
DEPTH DRILLED INTO ROCK:	DATE HOLE COMPLETED:
TOTAL DEPTH OF HOLE:	REFERENCE NO:
LOGGED BY:	CASING RECORD:

NOTES:

CHECKED BY: ____________

APPROVED BY: ____________

Proj. No. ____ Reviewed ____ Date ____

JOB NO ______ PROJECT ______ WELL NO ______ SHEET ______ OF ______

GA INSP ______ DRILLING METHOD ______ GROUND ELEV ______ WATER DEPTH ______

WEATHER ______ DRILLING COMPANY ______ COLLAR ELEV ______ DATE/TIME ______

TEMP ______ DRILL RIG ______ DRILLER ______ STARTED ______ TIME / DATE COMPLETED ______ TIME / DATE

LOCATION/COORDINATES ______

MATERIALS INVENTORY

WELL CASING ______ in dia ______ ft WELL SCREEN ______ in dia ______ ft BENTONITE SEAL ______

CASING TYPE ______ SCREEN TYPE ______ INSTALLATION METHOD ______

JOINT TYPE ______ SLOT SIZE ______ FILTER PACK QTY ______

GROUT QUANTITY ______ CENTRALIZERS ______ FILTER PACK TYPE ______

GROUT TYPE ______ DRILLING MUD TYPE ______ INSTALLATION METHOD ______

ELEV/DEPTH	SOIL/ROCK DESCRIPTION	WELL SKETCH	INSTALLATION NOTES
	GROUND SURFACE		
0.0			
			WELL DEVELOPMENT NOTES

Golder Associates

WELL DEVELOPMENT FIELD RECORD FIGURE

JOB NAME ______________ JOB NO. ______________ WELL NO. ______

DEVELOPED BY ______________ DATE OF INSTALL ______ SHEET ___ OF ___

STARTED DEVEL. ______ / ______ (DATE / TIME) COMPLETED DEVEL. ______ / ______ (DATE / TIME)

W.L. BEFORE DEVEL. ______ / ______ / ______ (DEPTH / DATE / TIME) AFTER DEVEL. ______ / ______ / ______ (DEPTH / DATE / TIME)

WELL DEPTH: BEFORE DEVEL. ______ AFTER DEVEL. ______ WELL DIA. (in) ______

STANDING WATER COLUMN (FT.) ______ STANDING WELL VOLUME ______ gal.

SCREEN LENGTH ______ DRILLING WATER LOSS ______ gal.

DATE/TIME	VOLUME REMOVED (GALS)	FIELD PARAMETERS SPEC. COND. (umhos/cm)	TEMP. (C°)	pH (s.u.)	OTHER	REMARKS
		= TOTAL VOLUME REMOVED (gal.)				

DEVELOPMENT METHOD: ______________

NOTES:

Golder Associates Inc.

SAMPLE COLLECTION FORM

PROJECT REF.: ____________________ PROJECT NO.: ____________

WEATHER CONDITIONS

PROJECT REF.: ________ CLOUD COVER ________ PRECIPITATION: ________

SAMPLE INFORMATION

SAMPLE NO.: ________ SAMPLE LOCATION: ________

SAMPLE DATE.: ________ TIME ________ SAMPLED BY: ________

MONITORING PROGRAM (e.g. DETECTION, COMPLIANCE) ________

IMMISCIBLE LIQUID MONITORING

DETECTION TECHNIQUE ________

IMMISCIBLE PHASE DETECTED? ☐ YES ☐ NO

DEPTH TO IMMISCIBLE PHASE/THICKNESS ________

SAMPLE METHOD[1] ________

VOLUME RECEIVED ________

SAMPLE CONTAINER ________

WATER SAMPLE

SAMPLE METHOD[1] ________

TECHNIQUE USED TO MEASURE DEPTH TO WATER ________

WATER LEVEL BEFORE PURGING ________

PURGING METHOD[1]: ☐ YES ☐ NO

VOLUME OF WATER REMOVED BEFORE SAMPLING: ________

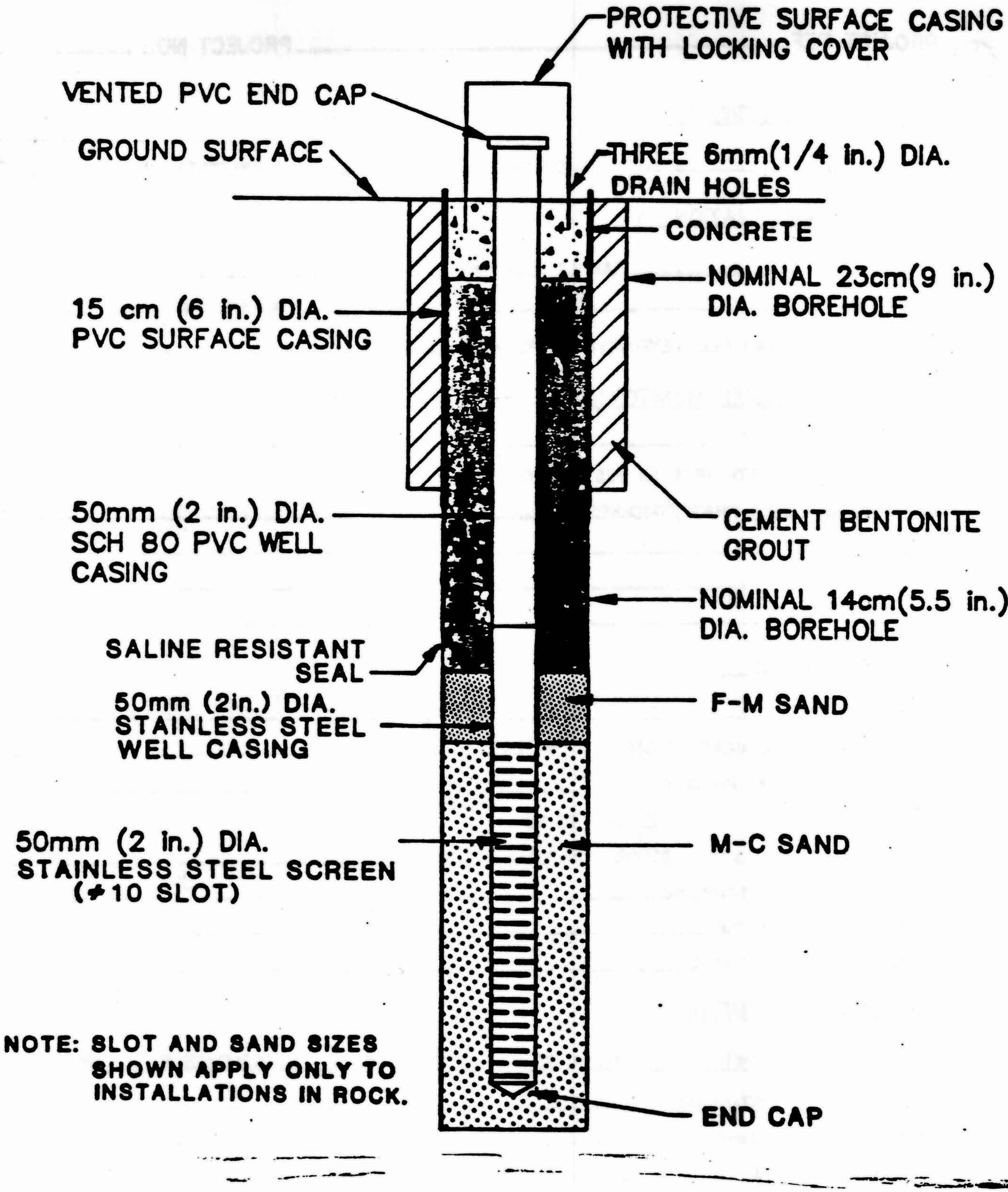
WATER LEVEL AFTER SAMPLING: ________

APPEARANCE OF SAMPLE: ________

DEPTH TO BOTTOM OF WELL: ________

FIELD MEASUREMENTS

PARAMETER	UNIT	REPLICATE 1	REPLICATE 2	REPLICATE 3	REPLICATE 4
pH	STANDARD				
SPEC. COND.	UMHOS/CM				
SALINITY	%				
TEMPERATURE	C				
TURBIDITY	N.T.U.				
DATE/TIME		/	/	/	/

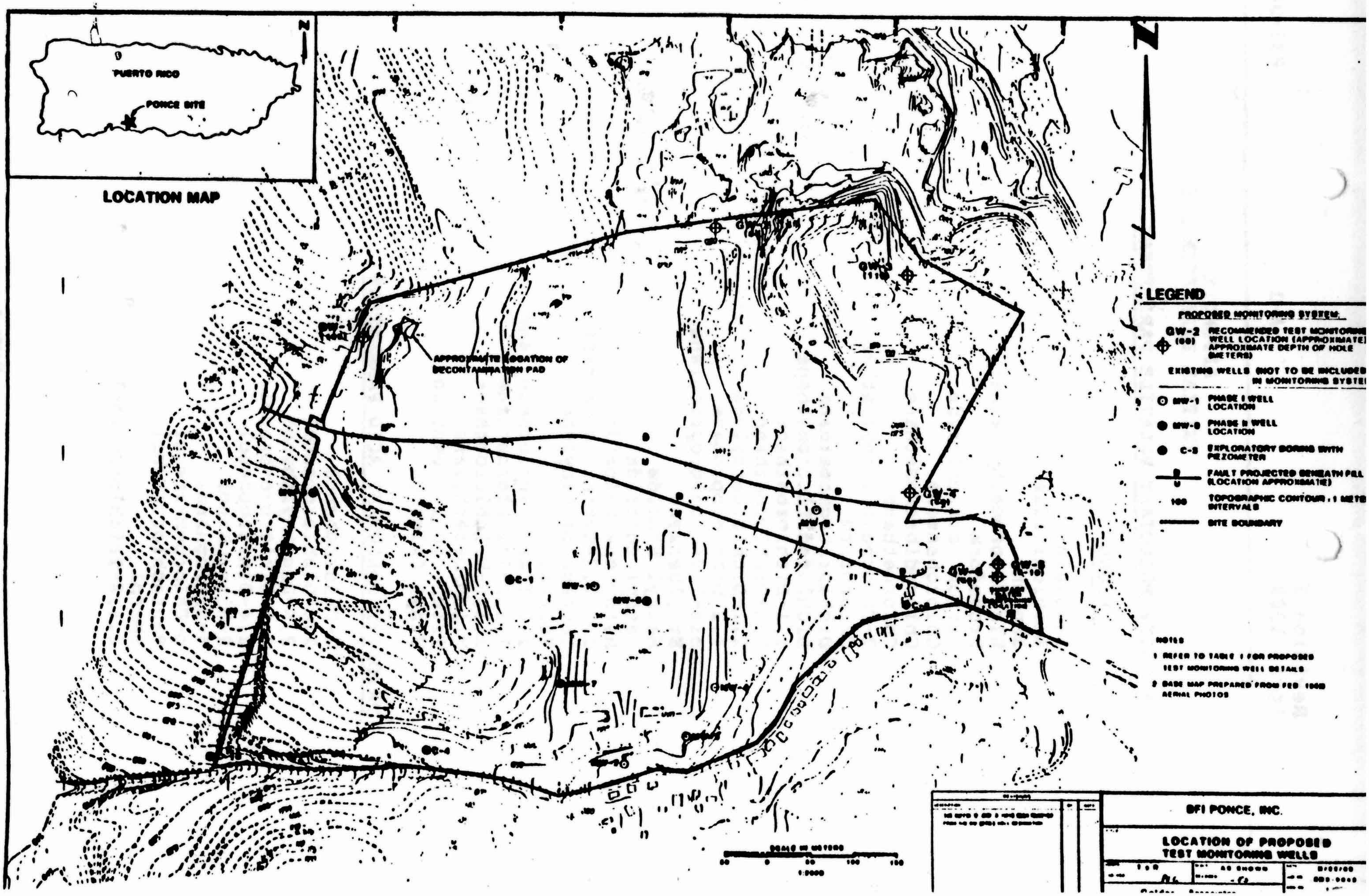


Golder Associates
Atlanta, Georgia

CLIENT/PROJECT
BFI OF PONCE, INC.

TITLE
TYPICAL TEST MONITORING WELL INSTALLATION DIAGRAM

DRAWN T.s.R.	CHECKED ALG	REVIEWED WRS	DATE 8/3/88	SCALE N.T.S	JOB NO. 883-3643
			FILE NO. 883-3643	DWG NO./REV. NO. 30 REV. 2	FIGURE NO. 7


LOCATION MAP
PUERTO RICO
PONCE SITE
APPROXIMATE LOCATION OF DECONTAMINATION PAD
LEGEND
PROPOSED MONITORING SYSTEM:
GW-2 (00) RECOMMENDED TEST MONITORING WELL LOCATION (APPROXIMATE) APPROXIMATE DEPTH OF HOLE (METERS)
EXISTING WELLS (NOT TO BE INCLUDED IN MONITORING SYSTEM)
MW-1 PHASE I WELL LOCATION
MW-8 PHASE II WELL LOCATION
C-3 EXPLORATORY BORING WITH PIEZOMETER
FAULT PROJECTED BENEATH FILL (LOCATION APPROXIMATE)
100 TOPOGRAPHIC CONTOUR: 1 METER INTERVALS
SITE BOUNDARY
NOTES
1 REFER TO TABLE 1 FOR PROPOSED TEST MONITORING WELL DETAILS
2 BASE MAP PREPARED FROM FEB 1986 AERIAL PHOTOS
SCALE IN METERS
BFI PONCE, INC.
LOCATION OF PROPOSED TEST MONITORING WELLS

APPENDIX A
INITIAL PARAMETER LIST

PRIORITY POLLUTANT VOLATILE PARAMETERS

COMPOUND

Acrolein
Acrylonitrile
Benzene
bis(Chloromethyl)ether
Bromoform
Carbon tetrachloride
Chlorobenzene
Chlorodibromomethane
Chloroethane
2-Chloroethylvinyl ether
Chloroform
Dichlorobromomethane
Dichlorodifluoromethane
1,1-Dichloroethane
1,2-Dichloroethane
1,1-Dichloroethylene
1,2-Dichloropropane
cis-1,3-Dichloropropylene
Ethylbenzene
Methyl bromide
Methyl chloride
Methylene Chloride
1,1,2,2-Tetrachloroethane
Tetrachloroethylene
Toluene
1,2-Trans-dichloroethylene
1,1,1-Trichloroethane
1,1,2-Trichloroethane
Trichloroethylene
Trichlorofluoromethane
Vinyl Chloride

PRIORITY POLLUTANT ACID PARAMETERS

2-Chlorophenol
2,4-Dichlorophenol
2,4-Dimethylphenol
4,6-Dinitro-o-cresol
2,4-Dinitrophenol
2-Nitrophenol
4-Nitrophenol
p-Chloro-m-cresol
Pentachlorophenol
Phenol
2,4,6-Trichlorophenol

PRIORITY POLLUTANT PESTICIDE PARAMETERS

Aldrin
Alpha-BHC
Beta-BHC
Gamma-BHC
Delta-BHC
Chlordane
4,4'-DDT
4,4'-DDE
4,4'-DDD
Dieldrin
Endosulfan I
Endosulfan II
Endosulfan sulfate
Endrin
Endrin aldehyde
Heptachlor
Heptachlor epoxide
PCB-1242
PCB-1254
PCB-1221
PCB-1232
PCB-1248
PCB-1260
PCB-1016
Toxaphene

PRIORITY POLLUTANT METALS

Arsenic (As)
Cadmium (Cd)
Chromium (Cr)
Lead (Pb)
Mercury (Hg)
Selenium (Se)
Silver (Ag)
Antimony (Sb)
Beryllium (Be)
Copper (Cu)
Zinc (Zn)
Nickel (Ni)
Thallium (Tl)

MISCELLANEOUS PRIORITY POLLUTANT PARAMETER

Total Cyanide

APPENDIX B

DECONTAMINATION OF DRILLING EQUIPMENT AND MATERIALS

All equipment, tools and materials used in drilling and well installation shall be decontaminated (cleaned) before being used at any hole or well on site and between holes or wells on site in accordance with the procedures outlined hereinafter.

1. The condition of the equipment shall be such that contamination is not created. Leaking seals or leaking tanks containing fluids other than water shall not be permitted.

2. Water used in decontamination shall be from the municipal water supply.

3. All equipment shall be degreased prior to mobilization to the site. Any lubrication of equipment after degreasing will be with vegetable oil.

4. All cleaning except the initial degreasing is to be performed on site in the area provided. Cleaning operations, including disposal of fluids and trash generated, will be done in accordance with the site's safety procedures and material handling conditions.

5. The drill rig will be steam cleaned utilizing municipal water. Steam cleaning units operated using compressed air shall be equipped with operable oil traps and a filter. The name, model and serial number of the steam cleaning unit will be recorded.

6. Drill rod, casing, pipe wrenches, etc., will be supported on horses or other supports and cleaned until all visible signs of grease, oil, mud, etc., are removed. Brushes shall be used as required.

7. All equipment will be steam cleaned. If practical, all equipment shall then be completely wrapped in plastic and taped such that the tape is on the plastic and not on the equipment.

8. New clean latex or cotton gloves will be used at each well location. Greasy gloves will be disgarded.

ATTACHMENT IV-3

WELL ABANDONMENT PROCEDURES

* References and citations made to specific sections, tables, figures or other sources which are not included in this Attachment are available in BFI's revised Post-Closure Permit application, dated May, 1989 and is in the Administrative Record. The Administrative Record is located at U. S. Environmental Protection Agency, Region II, Permits Administration Branch, 26 Federal Plaza, New York, N.Y., 10278 and the Puerto Rico Environmental Quality Board, Santurce, Puerto Rico, 00910-1488.

WATER WELL SEALING REPORT
(For Abandoned or Unused Wells)

LOCATION

County ______________ Township ______________ Section ______________
Property Owner ______________
Address of Property ______________
Location: ______________ miles ______________ of ______________
n, e, s, w — nearest intersection

on the ______________ side of ______________
n, e, s, w — road name

ORIGINAL WELL

Well Log Number ______________ Copy attached? Yes or No
(circle one)

MEASURED CONSTRUCTION DETAILS

Date of measurements ______________

Depth of Well ______________ Static Water Level ______________
Size of Casing ______________ Length of casing ______________
Well Condition ______________

SEALING PROCEDURE

Method of Placement ______________

			Sealing Material	Volume
Placement:	From ______	To ______	______	______
	From ______	To ______	______	______
	From ______	To ______	______	______

Was Casing Removed? Yes or No
(circle one)

Condition of Casing ______________
Perforations: From ______ To ______
From ______ To ______
Date Sealing Performed ______________
Reason(s) for Sealing ______________

CONTRACTOR

Name ______________ Registration # ______________
Address ______________
City/State/Zip ______________ Signature ______________

DECOMMISSIONING WELLS - TECHNIQUES AND PITFALLS

By Beth Lamb and Thomas Kinney

EMCON Associates
San Jose, California

ABSTRACT

Decommissioning wells properly is as critical as constructing wells properly. After installing thousands of monitoring wells to characterize sites throughout the country, it is now time for ground-water consultants to begin removing wells because they have become a liability. All wells can provide conduits for contaminant migration if they were improperly constructed or have been damaged in the course of their use. No well lasts forever; steel degrades, PVC breaks, well heads are damaged, and wells are covered. Some wells may already pose a threat because of poor construction techniques, such as the interconnection of water-bearing zones, and others may become conduits due to damage from extended use. Little attention has been paid to proper well decommissioning and wells that were not decommissioned or poorly decommissioned constitute a major threat to our ground-water supplies. Several techniques used and pitfalls encountered during decommissioning projects will be discussed. These projects implemented to protect ground-water monitoring systems included decommissioning deep and shallow monitoring wells, abandoned oil wells, and production water wells.

There are several ways to properly decommission a well. Decommissioning serves to seal off all potential conduits whether in the annular material, casing material, or in the well bore. The technique of well decommissioning depends on the original well construction, casing material, borehole conditions, annular seal, and water-bearing material. The most effective method for decommissioning is to overdrill and remove the entire well installation. The enlarged hole can then be sealed to the surface.

While well decommissioning is becoming more common, the process can be complicated. Inaccurate records of well construction or partially decommissioned wells can lead to major problems and increased cost in removing a well. Complex original construction methods such as piezometer nests and telescoped casing make overdrilling difficult. Additional problems have been encountered, such as circulation loss, PVC clogging the bit, borehole deviation, bit deflection, borehole caving, casing falling into the hole, and pumps or other tools becoming stuck in the well. These problems can lead to an incomplete decommissioning process and a well which is still a potential conduit for contaminant migration.

INTRODUCTION

A growing number of ground-water wells are being installed across the country for site characterization or contamination detection because of the current concern about protecting ground-water quality. In some sites there are more than 100 monitoring wells. Each ground-water monitoring well, production well, test well, and injection well creates a potential conduit for ground-water contamination. Oil wells can also pose a threat to ground-water. Wells can act as conduits for contaminant migration from the surface to the ground-water or between water-bearing zones. Improperly placed or constructed wells can jeopardize a ground-water monitoring system. Because no well lasts forever, all wells eventually need to be decommissioned. However, improper well decommissioning will also compromise water quality. Therefore, proper well decommissioning is as critical as correct well construction.

Commonly, wells must be decommissioned because (1) the well is no longer needed, (2) the well is not part of a new monitoring plan, (3) ground-water has dropped below the bottom of the well, (4) the well has been damaged, or (5) the well must be cleared away for new construction.

There are several reasons to decommission a well. The most immediate concern is that a well may provide a conduit to contaminant migration along the borehole due to damage or poor construction. Wells that are damaged can provide contaminant migration due to (1) broken well heads, (2) cracked casing, or (3) pitted and corroded steel. Wells that are poorly constructed can also provide contaminant migration along the borehole by connecting several water-bearing zones or having inadequate or broken seals.

This paper describes the decommissioning techniques that have been developed to avoid problems that have been encountered while decommissioning wells at several landfill and industrial sites in California. Most of the wells were deep (>100 feet) monitoring wells installed during early site assessments. Other wells were decommissioned because they were abandoned production wells with poor or unknown well constructions.

DEFINITIONS

Well decommissioning is the process of removing a well from service by closing down all access to the well (see Sara,1987). The term "abandoned" well, which is in common use, has an ambiguous meaning. An "abandoned" well does not imply that the well has been properly decommissioned. Abandoned wells may pose a threat to ground-water quality. An "abandoned" well is defined by the California Department of Water Resources (1981) as a well which has not been used for a period of one year. If the owner of the well demonstrates his intention to use the well again by properly maintaining the well, the well is termed "inactive". All "abandoned" wells in California must be destroyed. "Active" wells are ones that are being maintained as an operating well. A decommissioned well is one which has been "destroyed" proper to prevent degradation of water quality and eliminate potential physical hazards. In this paper the term decommissioned well refers to a well which has been put out of service by closing down the access to the aquifer by proper decommissioning techniques.

DECOMMISSIONING TECHNIQUES

There are several decommissioning techniques. The method used to decommission a well depends on the casing diameter, annular material, and depth. To correctly decommission a well it is important to know the original construction This information is often difficult to determine. The most reliable source of well construction detail is the well driller or a state regulatory agency. All well information data obtained should be verified by visual inspection before decommissioning begins. It is important to determine (1) casing type (e.g. PVC or steel), (2) casing diameter (including joint or telescoping diameters), (3) depth of well, (4) water level, and (5) any obstructions (e.g. pumps, lost drill bits or tools).

Two decommissioning techniques have been developed to avoid problems that commonly occur during well decommissioning. The overdrilling method or perforating and pressure-grouting method is used, depending on the original well construction. The overdrilling method enlarges the original boring by removing the casing and annular material. This method can not be used in decommissioning all wells including some (1) deep wells, (2) steel wells, (3) damaged wells, and (4) wells with very large diameters. These types of wells can be decommissioned using the perforating and pressure-grouting method. Both overdrilling and perforating the casing insure that any failures in the casing or annular materials which might provide conduits for migration are eliminated.

The following three steps are required to properly decommission a well.

1) Remove obstructions from the well
2) Remove or perforate the casing
3) Seal the borehole

Removing Obstructions

Initially, the well should be cleared of all obstructions. This requires pulling all pumps and piping. If obstructions can not be drilled out (for example, lost bits or tools) these item must be fished out before to decommissioning. Materials such as PVC or wood should be broken up and removed from the hole. Fill material must be cleaned out of the hole. If a well is not cleared to the original bottom, problems such as loss of circulation or twisting off a bit may occur during decommissioning.

Overdrilling Method

Overdrilling the original well installation is an effective way to decommission a well. The overdrilling method enlarges the borehole to eliminate all potential conduits to contaminant migration. It is suggested by Sara (1987) that the enlarged hole be 1.5 times larger than the original boring.

A two step technique has been developed to successfully decommission PVC monitoring wells using the overdrilling method. Initially the PVC casing is drilled out with a tri-cone rock bit to the top of the gravel-packed section (see Figure 1). This first run removes the PVC casing which has the potential for clogging the drill bit. Then an under-reaming bit with an attached pilot tool drills out the remaining casing, grout, and gravel-pack material (see Figure 1). The under-reaming bit is larger than the original boring and the pilot tool fits inside the drilled out casing hole. The pilot tool enables the under-reaming bit to follow the drill hole and avoid deflecting off the installation.

Mud rotary is the most effective drilling method to overdrill a boring and remove the casing in most wells over 40 feet deep. In mud rotary the drilling fluid keeps the hole open and brings the cuttings to the surface. In wells less than 40 feet deep air rotary drilling can be used, provided the drill rig can provide enough air pressure to lift the casing fragments and sandpack out of the hole.

Simpler overdrilling methods can be used for some shallow well installations. These include using hollow stem auger to drill out the casing, a backhoe to pull the casing, or digging the installation out. For these methods to be successful the well construction needs to be simple.

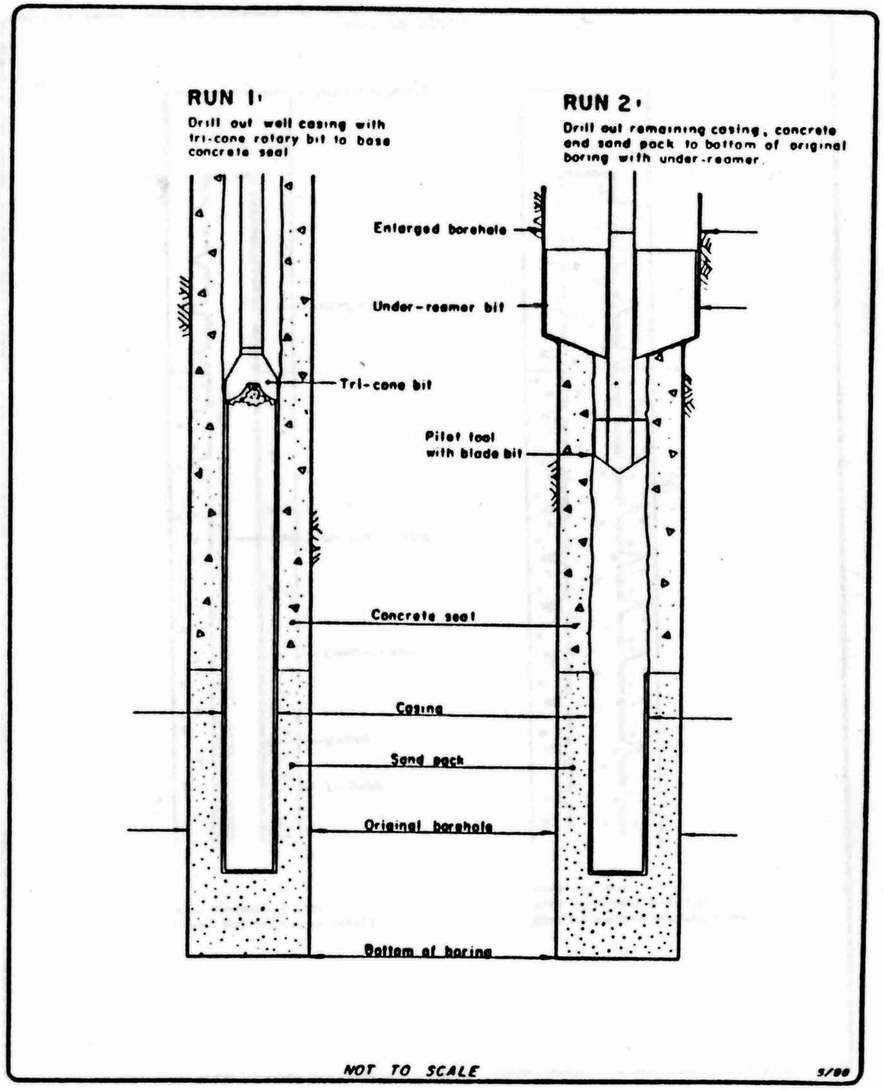


Figure 1. Overdrilling method

Perforating and Pressure-Grouting Method

When the overdrilling method is not possible, a perforating and pressure-grouting method can be used to decommission a well. In this method the casing and annular material is perforated with denotation or cutting tools (see Figure 2). Perforations should consist of a minimum number of shots to sufficiently fracture the casing and annular material. This would typically be about 4 shots per foot. If a perforating knife is used to cut the casing, the maximum blade width is typically 3/16 of an inch. The perforation tool should be run on a solid tool to insure the proper placement next to the casing in the well.

After the casing and annular material have been successfully perforated the borehole can be pressure grouted to seal all annular material. Pressure grouting forces grout into all fractures in the casing and annular material. This seals off any possible conduits to contaminant migration along the borehole (as described in the next section).

The perforating method can also be used in wells where conductor casing has been used to seal off upper aquifers. Wells constructed with steel conductor casing are a construction common in landfills and multi-layered aquifer systems. To decommission this type of well construction a combination of the overdrilling and perforating and pressure-grouting method can be used (see Figure 3). The first step is to drill out the PVC casing as described in the overdrilling method, with a tri-cone bit. This run is followed by the under-reaming bit with a pilot tool to excavate the casing, grout and gravel pack to the diameter of the conductor casing (see Figure 3). After the boring is enlarged, the steel-conductor casing can be perforated and the entire installation pressure grouted.

Sealing Methods

There are several methods to seal a well after the casing is removed or perforated (Nye,1987, Garber and Fisher,1988). The appropriate method depends on the original well construction. An important factor in sealing the boring is to avoid bridging of the grout. Bridging creates voids which could be paths for contaminant migration. Two sealing methods are appropriate for the decommissioning techniques describe previously either from the bottom up through a pipe or pressure-grouting.

Bridging of grout will not occur if grout is installed through a tremie pipe or hollow stem augers. This allows the grout to be placed at the bottom of the borehole. As the grout fills in the boring the tremie pipe or augers are raised to prevent bridging. If the casing and annular material has been perforated using only a tremie pipe sealing method does not place enough pressure on the grout to force it into the perforations.

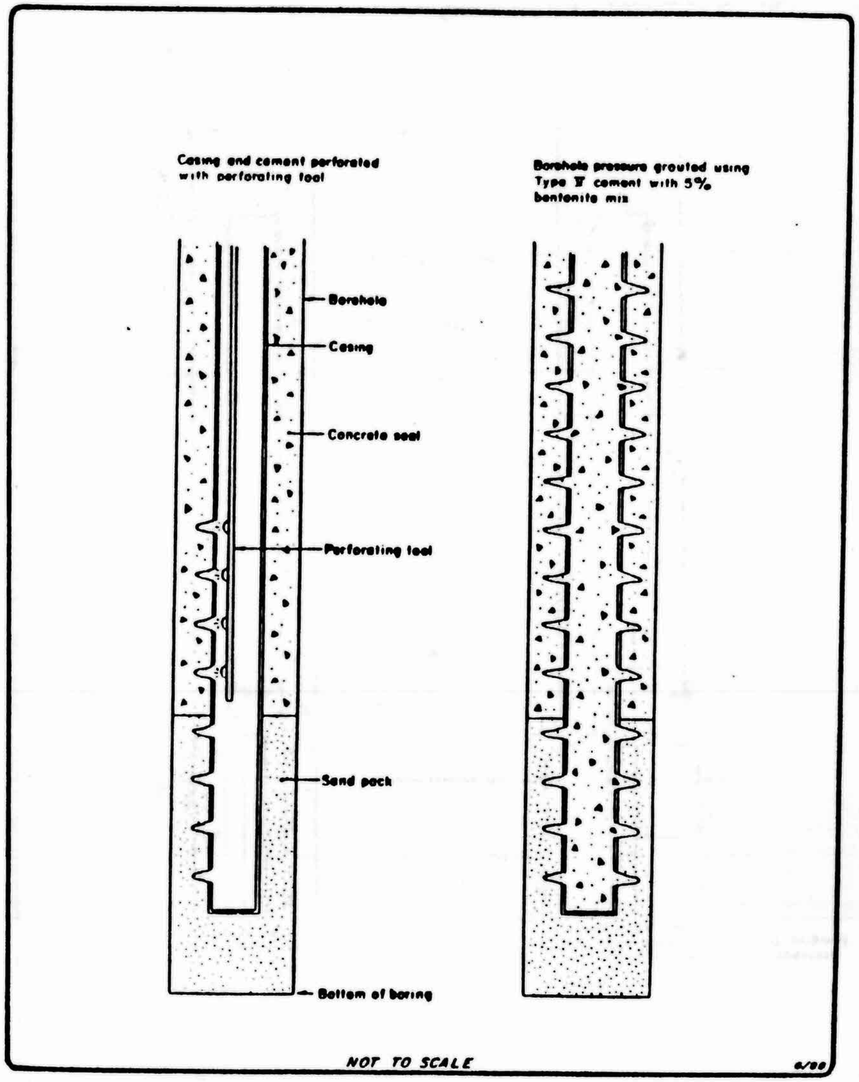


Figure 2. Perforating and pressure grouting method

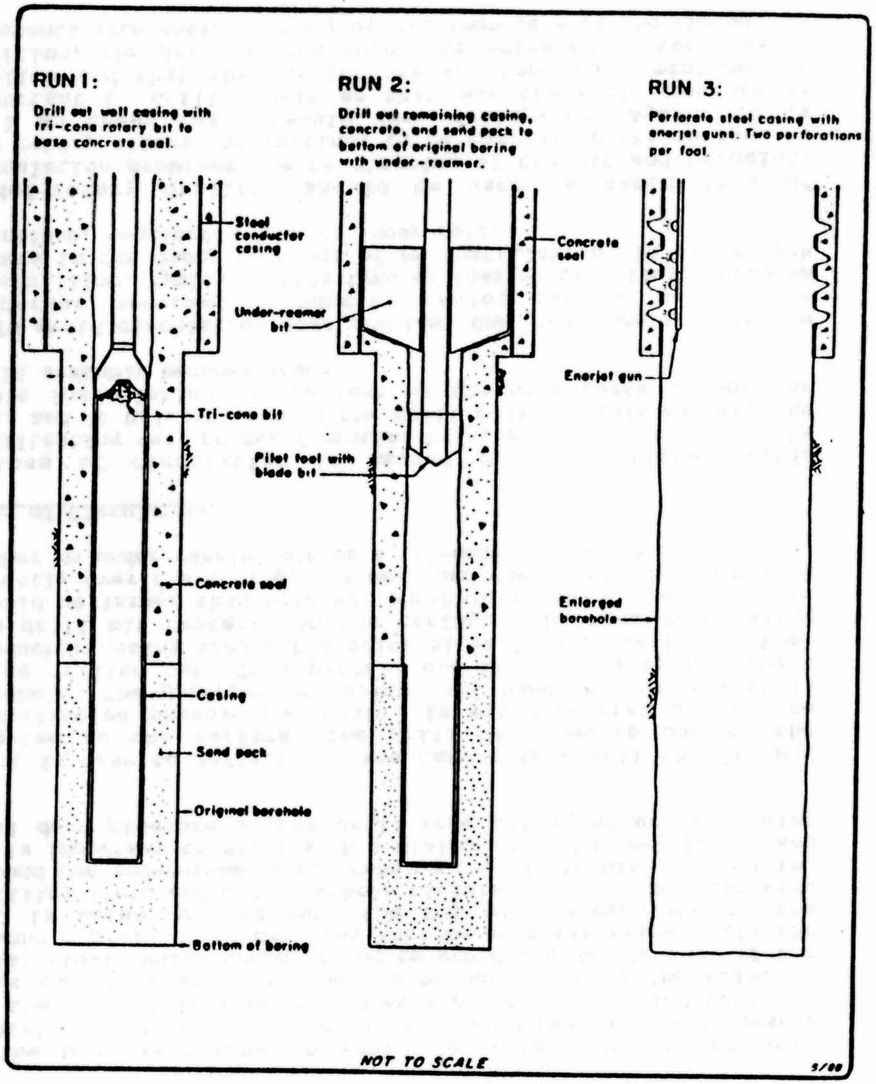


Figure 3. Decommissioning a well with steel conductor casing

The pressure-grouting method pumps grout into the boring which forces the grout to fill all voids in the casing and annular space. For pressure grouting, a tremie pipe is placed at the bottom of the well and a casing cap with an air relief valve is placed on top of the well. The grout is pumped until the casing volume is exceeded by 30 percent, or until 25 pounds of back pressure is obtained.

The type of grout used depends on the formation environment. Types of cement and additives available are discussed in detail in Halliburton Cementing Tables (1981). For example, in areas where water is corrosive, Type V cement should be used to avoid problems of grout failure and Calcium Chloride could be added to reduce drying time.

Most grout settles down slowly. Consequently it is important to grout up a deep hole in lifts. Between each lift the grouted section is allowed to set before placing the next lift. Neat cement tends to shrink and crack. Therefore a grout mixture with some bentonite should be used in the seal for well decommissioning.

After the final grout lift has been installed, the decommissioned well should be permanently marked, surveyed and reported to the state regulatory board. This final step insures that future investigators are aware that the well was properly decommissioned.

DECOMMISSIONING PITFALLS

A well generally needs to be decommissioned because it is damaged, which can make the process of decommissioning more difficult than the well installation. Many times well decommissioning becomes complicated when well construction is unknown or different than reported. There are several types of problems encountered during decommissioning, most of which are related to using the overdrilling method. The most common decommissioning problems are bit deflection, loss of circulation, and twisting off. The following section discusses these problems and gives suggestions on how to avoid these decommissioning pitfalls.

Bit Deflection

The most common problem when drilling out a well is for the drill bit to deviate out of the original borehole. The driller will usually be able to determine when this occurs because if the bit deviates out of the well installation into the formation, torque and chattering will decrease.

The best technique to avoid deviating out of the well installation is to drill out the well with two runs as suggested in the overdrilling method. When a pilot bit is used there is less chance to deviate from the borehole. It is important to drill slowly while overdrilling to avoid bit deflection. If the downhole pressure or drilling rate becomes excessive while the PVC is being drilled out, the PVC will accumulate in the drilling fluid and plug downhole circulation. PVC can also wrap around the under-reaming bit causing the bit to bind. Therefore, it is important to drill with a minimum drilling revolution and pull down pressure on the drill rods using the under-reaming bit.

It is easy to deflect off the casing in a well that is not grouted to the surface. The drill bit wanders out of the installation because the casing is not supported within the borehole. The unsupported casing may bend while the well is being drilled out. This pitfall can be avoided by placing a conductor casing around the original well installation to keep the drill bit centered on the casing. The conductor casing should be larger than original borehole to guide the drill bit directly over the casing. The well can then be drilled out with either an under-reaming bit or a tri-cone rotary bit.

Loss of Circulation

Loss of circulation is caused by 1) drilling fluids infiltrating very porous formation material, 2) PVC clogging the bit, and 3) bridging around the drill rods. If this happens the whole installation can be lost as the hole caves in and the drill assembly becomes stuck.

To avoid circulation loss problems due to decommissioning in a porous material, conductor casing can be set before overdrilling. Typically this type of loss of circulation problem occurs in the upper portions of an installation, in areas such as refuse, engineered fill or loose soil.

Mud-rotary drilling should be used to avoid loss of circulation problems due to clogging of the bit and bridging. Mud rotary allows the cuttings to be carried to the surface as well as keeps the borehole from collapsing. Again, it is important to drill slowly so that not too much pressure is applied and that the revolutions are kept to a minimum. In addition, the drilling mud should be screened to keep casing fragments from entering the pump and then re-entering the well.

Twisting Off

Another pitfall to be avoided during well decommissioning is twisting off a drill bit. This happens when a rotary drill rig shears off the drill bit and/or some of the drill rods. This can

be caused by high torque created by drilling out the casing and grout or if circulation is lost in the hole. When this happens the drill bits and rods need to be retrieved from the hole, which significantly increases the time and cost of decommissioning.

Mud rotary is the best drilling method to avoid twisting off, because the hole can easily be kept clean. High torque and circulation problems can cause the bit to twist off; therefore, drilling should be slow to insure that not too much weight is applied and the drilling revolutions are kept to a minimum.

Twisting off can also occur if the drill bit encounters an obstruction in the borehole. This has included pumps, steal pipe and other metal objects. To avoid this pitfall, the well should be cleared out to the original bottom before the well is decommissioned.

CONCLUSION

Proper decommissioning is as important as proper water well construction. The technique used to decommission a well depends on the well construction. Two techniques are used to decommission a well, an overdrilling method and a perforation and pressure-grouting method.

To avoid problems in decommissioning it is important to know the well construction. When overdrilling a well, mud rotary is a good drilling method to remove the casing and annular material. In mud rotary the drilling fluids will control caving, and remove casing fragments and annular material from the hole. While overdrilling a well it is important to drill slowly to avoid the decommissioning pitfalls of deviating off the well installation, loss of circulation, or twisting off drill bits.

Currently there are a greater number of ground-water wells being installed to monitor ground water for environmental assessments. Because every well installed will one day need to be decommissioned, it is prudent to consider well decommissioning before the well is even installed. In some places temporary wells may be installed, or a 50/50% bentonite cement grout mix could be used. This would allow the well to be easily pulled during well decommissioning and avoid expensive decommissioning costs.

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BIOGRAPHICAL SKETCHES

Beth Lamb is a Project Hydrogeologist with EMCON Associates in San Jose, California. She received a B.A. in Geology from the University of Santa Barbara and a M.A. in Geology from the State University of New York at Buffalo. She spent 3 years working on engineering geology mapping projects in Alaska for the USGS. She is currently working on hydrogeological site investigations, aquifer analysis, and ground-water remediation projects. During the last 4 years she has worked on establishing ground-water monitoring programs at several large landfill sites.

Thomas Kinney is a Geologist with EMCON Associates in San Jose, California. He received a B.S. in Geology From Central Michigan University. Currently, he provides geological support on hydrogeologic site assessments, geologic mapping, and seismic studies. Before working at EMCON, he was a drilling supervisor and logging geologist for engineering firms in California and Michigan.

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ATTACHMENT IV-4

SAMPLING PROCEDURES

* References and citations made to specific sections, tables, figures or other sources which are not included in this Attachment are available in BFI's revised Post-Closure Permit application, dated May, 1989 and is in the Administrative Record. The Administrative Record is located at U. S. Environmental Protection Agency, Region II, Permits Administration Branch, 26 Federal Plaza, New York, N.Y., 10278 and the Puerto Rico Environmental Quality Board, Santurce, Puerto Rico, 00910-1488.

ATTACHMENT 6

QUALITY ASSURANCE PLAN
FOR LABORATORY ANALYSIS AND
FIELD INSTRUMENT MAINTENANCE
PONCE MUNICIPAL LANDFILL
PONCE, PUERTO RICO

Revision 1
April 1989

883-3643

SAMPLES COLLECTED (LISTED IN SEQUENCE COLLECTED)

SUB-SAMPLE	ANALYSIS REQUIRED	TYPE AND SIZE OF SAMPLE CONTAINER	FILTER SIZE	TYPE AND AMOUNT OF PRESERVATIVE ADDED
1				
2				
3				
4				
5				
6				

INTERNAL TEMPERATURE OF FIELD CONTAINER ______

INTERNAL TEMPERATURE OF SAMPLE SHUTTLE ______

TRANSPORTER NAME: ______

NAME OF LABORATORY TO PERFORM ANALYSIS ______

REMARKS: ______

SAMPLING METHOD [1] (CHOOSE ONE)

AIR-LIFT PUMP
BAILER – PVC
– STAINLESS STEEL
– TEFLON
KEMMERER

PERISTALTIC PUMP
PISTON PUMP
SUBMERSIBLE PUMP
SUCTION LIFT PUMP
OTHER (SPECIFY)

SAMPLE COLLECTION FORM

PROJECT REF.: ______________________ PROJECT NO.: ______________

WEATHER CONDITIONS

PROJECT REF.: __________ CLOUD COVER __________ PRECIPITATION: __________

SAMPLE INFORMATION

SAMPLE NO.: __________ SAMPLE LOCATION: __________

SAMPLE DATE.: __________ TIME __________ SAMPLED BY: __________

MONITORING PROGRAM (e.g. DETECTION, COMPLIANCE) __________

IMMISCIBLE LIQUID MONITORING

DETECTION TECHNIQUE __________

IMMISCIBLE PHASE DETECTED? ☐ YES ☐ NO

DEPTH TO IMMISCIBLE PHASE/THICKNESS __________

SAMPLE METHOD[1] __________

VOLUME RECEIVED __________

SAMPLE CONTAINER __________

WATER SAMPLE

SAMPLE METHOD[1] __________

TECHNIQUE USED TO MEASURE DEPTH TO WATER __________

WATER LEVEL BEFORE PURGING __________

PURGING METHOD[1]: ☐ YES ☐ NO

VOLUME OF WATER REMOVED BEFORE SAMPLING: __________

WATER LEVEL AFTER SAMPLING: __________

APPEARANCE OF SAMPLE: __________

DEPTH TO BOTTOM OF WELL: __________

FIELD MEASUREMENTS

PARAMETER	UNIT	REPLICATE 1	REPLICATE 2	REPLICATE 3	REPLICATE 4
pH	STANDARD				
SPEC. COND.	UMHOS/CM				
SALINITY	%				
TEMPERATURE	C				
TURBIDITY	N.T.U.				
DATE/TIME		/	/	/	/

TABLE 1

PRESERVATION AND HOLDING TIME REQUIREMENTS

ANALYTE	MATRIX	HOLDING TIME (1)	PRESERVATION	CONTAINER
Volatile Organics	Solid	7 days	cool, 4 degrees C	2x40 ml glass Teflon septum
Extractable Organics	Solid	10 days to extraction, 40 days to analysis	cool, 4 degrees C	8 oz. glass
Cyanide	Solid	6 months	cool, 4 degrees C	8 oz. glass
Metals	Solid	6 months	cool, 4 degrees C	8 oz. glass
Mercury	Solid	6 months	cool, 4 degrees C	8 oz. glass
Volatile Organics	Aqueous	10 days	low/medium conc.: HCl to pH <2 then cool, 4 degrees C	2x40 ml glass Teflon septum
Extractable Organics	Aqueous	7 days to extraction, 40 days to analysis	low/medium conc.: cool, 4 degrees C	1 gallon amber glass
Cyanide	Aqueous	14 days	cool, 4 degrees C NaOH pH>12, cadmium carbonate if S^{-2} present	low conc.: 1 liter polyethylene
Metals (unfiltered)	Aqueous	6 months	cool, 4 degrees C, HNO_3 pH<2	low conc.: 1 liter polyethylene
Metals (filtered)	Aqueous	6 months	filtered(2), cool, 4 degrees C, HNO_3 pH<2	low conc.: 1 liter polyethylene
Mercury	Aqueous	26 days	cool, 4 degrees C, HNO_3 pH<2	low conc.: 1 liter polyethylene

NOTE: (1) All holding times are from date of sample collection.

(2) Sample will be filtered using an 0.45 micron cellulose ester filter.

Table 2

PROPOSED ANALYTICAL METHODS FOR THE PARAMETERS ANALYZED
AT THE PONCE MUNICIPAL LANDFILL, PUERTO RICO

Laboratory	Method Numbers (Not For Appendix IX) ESE	RADIAN	Method Numbers For Appendix IX ESE & RADIAN
Volatiles	624	624	8240**
Acid/Base/Neutrals	625	625	8270
PCB/ORG.Cl Pesticides	608	608	8080
Organophosphorous Pesticides	NA	NA	8140
Organochlorine Herbicides	NA	NA	8150
Chlorinated Dioxins & Furans	NA	NA	8280
As Arsenic	206.2	206.2	6010
Cd Cadmium	200.7	200.7	6010
Cr Chromium	200.7	200.7	6010
Pb Lead	200.7	200.7	6010
Hg Mercury	245.1	245.1	7470
Se Selenium	270.2	270.2	6010
Ag Silver	200.7	200.7	6010
Sb Antimony	200.7	200.7	6010
Be Beryllium	200.7	200.7	6010
Cu Copper	200.7	200.7	6010
Zn Zinc	200.7	200.7	6010
Ni Nickel	200.7	200.7	6010
Tl Thallium	279.2	279.2	6010
Ba Barium	NA	NA	6010
Co Colbalt	NA	NA	6010
V Vanadium	NA	NA	6010
Free & amen. CN	9012	9012	9012
Total CN	335.2	335.3*	9012
Ca Calcium	200.7	200.7	NA
Mg Magnesium	200.7	200.7	NA
Na Sodium	200.7	200.7	NA
K Potassium	200.7	200.7	NA
Cl Chloride	325.2*	325.3	NA
Fe Iron (total)	200.7	200.7	NA
SO4 Sulfate	375.4	375.4	NA
PO4 Phosphate (total)	365.1	365.1	NA
NH4 Ammonia	350.1	350.1	NA
NO3 Nitrate	353.1	353.2	NA
NO2 Nitrite	353.1	353.2	NA
Alkalinity	310.1	310.1	NA
Sn Tin	NA	NA	7480
S Sulfide	NA	NA	9030
pH	120.1	120.1	NA
Specific conductance	150.1	150.1	NA

NOTES: (1) Method numbers obtained from ESE and Radian plans provided in Appendices A & B.

(2) NA - Not Applicable.

(3) * Method number transposed in the manual. However reasonable interpretation suggests the listed method number.

(4) ** Plus direct injection.

Table 3
RFA SOIL SAMPLING

	SOIL				WATER		
	Investigative	Duplicate	Matrix Spike	Matrix Spike Duplicate	Rinsate Blank	Trip Blank	TOTAL
COVER SOIL							
frequency - once							
prespecified locations							
Volatiles	9	1	1	1	1	1	14
A/B/N	9	1	1	1	1	0	13
Metals	9	1	1	1	1	0	13
Pests+PCBs	9	1	1	1	1	0	13
Cyanide	9	1	1	1	1	0	13
Physical	5	0	0	0	0	0	5
from HNU scan (provisional number - depends on HNU scan results)							
Volatiles	2	0	0	0	0	1	3
A/B/N	2	0	0	0	0	0	2
Metals	2	0	0	0	0	0	2
Pests+PCBs	2	0	0	0	0	0	2
Cyanide	2	0	0	0	0	0	2
Physical	0	0	0	0	0	0	0
borrow pit Juana Diaz							
Volatiles	3	1	0	0	1	0	5
A/B/N	3	1	0	0	1	0	5
Metals	3	1	0	0	1	0	5
Pests+PCBs	3	1	0	0	1	0	5
Cyanide	3	1	0	0	1	0	5
Physical	1	0	0	0	0	0	1
borrow pit Ponce							
Volatiles	3	0	0	0	1	0	4
A/B/N	3	0	0	0	1	0	4
Metals	3	0	0	0	1	0	4
Pests+PCBs	3	0	0	0	1	0	4
Cyanide	3	0	0	0	1	0	4
Physical	1	0	0	0	0	0	1
SUBTOTAL	92	10	5	5	15	2	129
SOIL BENEATH							
frequency - once							
6 Test pits at 2 depths (more samples may be taken if contamination is encountered)							
Volatiles	12	2	1	1	1	1	18
A/B/N	12	2	1	1	1	0	17
Metals	12	2	1	1	1	0	17
Pests+PCBs	12	2	1	1	1	0	17
Cyanide	12	2	1	1	1	0	17
Physical	4	0	0	0	0	0	4
SUBTOTAL	64	10	5	5	5	1	90

NOTE: (1) Number of rinsate and trip blanks depend on the equipment used and number of samples shuttles used.
(2) A/B/N means acid and base/neutral extractables.
Pests means the Priority Pollutant pesticides.
PCBs means the Priority Pollutant polychlorinated biphenyl aroclors.

Table 4
GROUNDWATER SAMPLING

	Investigative	Duplicate	Matrix Spike	Matrix Spike	Rinsate Blank	Trip Blank	Field Blank	TOTAL
BASELINE MONITORING								
frequency - once								
Volatiles	6	1	1	1	0	1	1	11
A/B/N	6	1	1	1	0	0	1	10
Metals	6	1	1	1	0	0	1	10
Pests+PCBs	6	1	1	1	0	0	1	10
Cyanide	6	1	1	1	0	0	1	10
Non PPs	6	1	0	0	0	0	1	8
SUBTOTAL	36	6	5	5	0	1	6	59
BACKGROUND MONITORING								
frequency - 4 quarters only - types of samples depends on those chosen for the detection monitoring list								
Volatiles	6	1	0	0	0	1	1	9
A/B/N	6	1	0	0	0	0	1	8
Metals	6	1	0	0	0	0	1	8
Pests+PCBs	6	1	0	0	0	0	1	8
Cyanide	6	1	0	0	0	0	1	8
SUBTOTAL	30	5	0	0	0	1	5	41
DETECTION MONITORING								
frequency - semi-annually - types of samples depends on those specified on the detection monitoring list								
Volatiles	6	1	0	0	0	1	1	9
A/B/N	6	1	0	0	0	0	1	8
Metals	6	1	0	0	0	0	1	8
Pests+PCBs	6	1	0	0	0	0	1	8
Cyanide	6	1	0	0	0	0	1	8
SUBTOTAL	30	5	0	0	0	1	5	41
COMPLIANCE MONITORING								
frequency - quarterly sampling - sample annually for all Appendix IX parameters, other 3 quarters - sample for the specified parameters on the compliance monitoring list.								
Volatiles	6	1	0	0	0	1	1	9
A/B/N	6	1	0	0	0	0	1	8
Metals	6	1	0	0	0	0	1	8
Pests+PCBs	6	1	0	0	0	0	1	8
Herbs	6	1	0	0	0	0	1	8
Dioxins	6	1	0	0	0	0	1	8
Cyanide	6	1	0	0	0	0	1	8
Other (1)	6	1	0	0	0	0	1	8
SUBTOTAL	48	8	0	0	0	1	8	65

NOTES: (1) Other Appendix IX parameters.

(2) A/B/N means acid and base/neutral extractables.
PP means Priority Pollutants.
Pests means the Priority Pollutant pesticides.
PCBs means the Priority Pollutant polychlorinated biphenyl aroclors.

(3) Number of rinsate and trip blanks depend on the equipment used and number of samples shuttles used.

(4) Numbers of samples are based on a monitoring system comprised of 6 wells.

Table 5
SURFACE WATER SAMPLING

	Investigative	Duplicate	Matrix Spike	Matrix Spike Duplicate	Rinsate Blank	Trip Blank	Field Blank	TOTAL
BASELINE MONITORING								
frequency - once								
Volatiles	1	1	1	1	0	1	1	6
A/B/N	1	1	1	1	0	0	1	5
Metals	1	1	1	1	0	0	1	5
Pests+PCBs	1	1	1	1	0	0	1	5
Cyanide	1	1	1	1	0	0	1	5
Non PPs	1	1	0	0	0	0	1	3
SUBTOTAL	6	6	5	5	0	1	6	29
BACKGROUND AND DETECTION MONITORING								
frequency as groundwater monitoring - if stream is running - parameters as on the detection monitoring list								
Volatiles	1	1	0	0	0	1	1	4
A/B/N	1	1	0	0	0	0	1	3
Metals	1	1	0	0	0	0	1	3
Pests+PCBs	1	1	0	0	0	0	1	3
Cyanide	1	1	0	0	0	0	1	3
SUBTOTAL	5	5	0	0	0	1	5	16
COMPLIANCE MONITORING								
frequency - semi-annually - if stream is running - parameters as on the compliance monitoring list								
Volatiles	1	1	0	0	0	1	1	4
A/B/N	1	1	0	0	0	0	1	3
Metals	1	1	0	0	0	0	1	3
Pests+PCBs	1	1	0	0	0	0	1	3
Herbs	1	1	0	0	0	0	1	3
Dioxins	1	1	0	0	0	0	1	3
Cyanide	1	1	0	0	0	0	1	3
SUBTOTAL	7	7	0	0	0	1	7	22

NOTES:

(1) A/B/N means acid and base/neutral extractables.
PP means Priority Pollutants.
Pests means the Priority Pollutant pesticides.
PCBs means the priority pollutant polychlorinated biphenyl aroclors.

Table 6
MISCELLANEOUS QA SAMPLES

	Municipal Water Sample	Drill Rod Rinsate Sample	Trip Blank	Field Blank	TOTAL
WELL INSTALLATION (WATER)					
Volatiles	1	1	1	1	4
A/B/N	1	1	0	1	3
Metals	1	1	0	1	3
Pests+PCBs	1	1	0	1	3
Cyanide	1	1	0	1	3
Non PPs	1	1	0	1	3
SUBTOTAL	6	6	1	6	19

	Drill Cuttings	Trip Blank	Total
WELL INSTALLATION (SOIL)			
Volatiles	3	3	6
A/B/N	3	0	3
Metals (Total)	3	0	3
Cyanide (Total)	3	0	3
SUBTOTAL	12	3	15

	Sump Liner Rinsate Sample	Trip Blank	Field Blank	Total
SUMP LINER (WATER)				
Volatiles	1	1	1	3
A/B/N	1	0	1	2
Metals (Total)	1	0	1	2
Cyanide (Total)	1	0	1	2
SUBTOTAL	4	1	4	9

NOTES:

(1) A/B/N/ means acid and base/neutral extractables.
PP means Priority Pollutants.
Pests means the Priority Pollutant pesticides.
PCBs means the priority pollutant polychlorinated biphenyl aroclors.

(2) Number of Drill Cuttings Samples is dependent on the number of borings drilled.

REFERENCES

1. US EPA Contract Laboratory Program, 1987, Statement of Work for Inorganics Analysis, Multi-Media, Multi-Concentration, SOW No. 787.

2. US EPA Contract Laboratory Program, 1986, Statement of Work For Organics Analysis, Multi-Media, Multi-Concentration, Rev. February 1987.

3. EPA Region II, 1988, CERCLA Quality Assurance Manual.

4. US EPA, 1988, Laboratory Data Validation, Functional Guidelines for Evaluating Organics Analyses.

5. EPA Region II, 1988, Evaluation of Metals Data For the Contract Laboratory Program, SOP No. HW-2, Rev. VII.

6. Golder Associates Inc.,1988, RFA Work Plan, Cover Soil Sampling, Ponce Municipal Landfill, Ponce, Puerto Rico, Revision 2 issued April 1989. Latest revision is applicable.

7. Golder Associates Inc.,1988, RFA Work Plan, Sampling of Soil Beneath Landfill, Ponce Municipal Landfill, Ponce, Puerto Rico, Revision 2 issued April 1989. Latest revision is applicable.

8. Golder Associates Inc., 1988, Groundwater Monitoring Plan, Ponce Municipal Landfill, Ponce, Puerto Rico, Revision 2 issued April 1989. Latest revision is applicable.

3.3.6 <u>Field Instrument Calibration and Preventative Maintenance</u>

Field instrument calibration and preventative maintenance are included in Appendices D and E of this document.

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The above blanks and duplicates are considered adequate with the proposed monitoring system, as described in Reference 8. This section will be reviewed and appropriate revisions will be made if any change in the monitoring network is implemented.

3.3.4 Sample Custody

The field custody procedures are noted in the Groundwater Monitoring Plan (Reference 8). The chain-of-custody form to be used is that in the Radian Plan.

3.3.5 Data Reduction Validation and Reporting

The standard deliverable, required from the laboratory, will contain the sample number, laboratory sample identification number, result, unit, detection limit, and the appropriate laboratory qualifiers. The Radian Plan will govern the internal laboratory work for the MQA. All potential analytical problems will be discussed with the prime contractor (Golder) and a narrative will be sent to US EPA as appropriate. Data will be transferred from the laboratory to the prime contractor (Golder) by disk where it will be incorporated into a relational and/or flat file database. The data will be reported to US EPA in tabular form with a narrative discussing the complete sampling and analysis event. Further information is included in Sections 8.0, 9.0 and 10.0 of the Groundwater Monitoring Plan (Reference 8).

3.3.1 Applicability and Methodologies

The MQA will be used for all groundwater monitoring except the baseline monitoring sampling for Priority Pollutants, as described in the Groundwater Monitoring Plan. The methods used will be those stated in Table 2.

3.3.2 Sample Container, Preservative Techniques, Holding Times

Table 4-1 of the Radian Plan (see Appendix A) lists the containers, preservation techniques and holding times that would be used on water samples analyzed by Radian as part of the MQA.

3.3.3 Sampling Blanks and Duplicates

- Trip blanks will be 40 ml VOA vials with Teflon septa lids. The vials will be filled with analyte-free or HPLC grade water at the laboratory and accompany the bottles from the laboratory, into the field and back to the laboratory. Trip blanks will be taken when aqueous samples are analyzed for volatiles. The trip blanks will be taken at a frequency of one per day per aqueous matrix or one per shipment, whichever is more frequent. Trip blanks will be analyzed for the volatile organic compounds for which investigative samples are being analyzed at a frequency of at least one per aqueous matrix per week or per sampling event, whichever frequency is greater.

- Rinsate blanks will be obtained as specified in the sampling plans.

- One duplicate will be obtained for every sampling event.

- If a resampling is necessary a sample may be split with another commercial laboratory.

- Splits for use by the US EPA Region II will be obtained as requested.

- Tables 4 and 5 list the types of samples by matrix.

- Table 6 lists additional samples and sampling blanks to be taken during the field program as described in Reference 8.

and the prime contractor (Golder). Golder will also validate the data using US EPA, "Laboratory Data Validation, Functional Guidelines for Evaluating Organics Analysis," (Reference 4) and US EPA Region II "Evaluation of Metals Data for the Contract Laboratory Program" (Reference 5).

QC summary sheets, results and narrative will be supplied to US EPA Region II. Raw data will not be included. Data will be transferred from the laboratory to the prime contractor (Golder) by disk where it will be incorporated into a relational and/or flat file database. The data will be reported to US EPA in tabular form with a narrative discussing the complete sampling and analysis event. Further information is included in the soil sampling plans (References 6 and 7) and in the Groundwater Monitoring Plan (Reference 8).

3.2.6 Field Instrument Calibration and Preventative Maintenance

Field instrument calibration and preventative maintenance are included in Appendices D and E of this document.

3.2.7 Miscellaneous

QA will not be run by the batch method, but instead on project specific samples as specified by the CLP procedures.

3.3 Monitoring QA (MQA)

The Radian plan provides for the complete laboratory procedures, chain-of-custody, and sample container labeling for the MQA, and is included as Appendix A. The actual methods to be used are shown in Table 2.

- o Rinsate blanks will be obtained as specified in the sampling plans.
- o One duplicate will be obtained per 10 investigative samples.
- o If a resampling is necessary a sample may be split with another commercial laboratory.
- o Splits for use by the US EPA Region II will be obtained as requested.
- o Additional QA samples will be obtained to allow for CLP SOW Matrix Spikes etc.
- o Tables 3, 4 and 5 list the types of samples by matrix.
- o Table 6 lists additional samples and sampling blanks to be taken during the Field program as described in Reference 8.

The above blanks and duplicates are considered adequate with the proposed monitoring system and the proposed soil sampling events (see References 6, 7, and 8). This section will be reviewed and appropriate revisions will be made if any change in the monitoring network is implemented.

3.2.4 Sample Custody

The field custody procedures are noted in the Groundwater Monitoring Plan (Reference 8) and in the soil sampling plans (References 6 and 7). The chain-of-custody form to be used is presented in the Radian Plan. Each shipment containing soil will be accompanied by a USDA permit label, provided by the laboratory. The laboratory permit is included with the QA Plan in Appendix A.

3.2.5 Data Reduction Validation and Reporting

Deliverables from the laboratory will contain all elements of a CLP package, but will not necessarily be presented on the CLP forms. Data reduction and validation will be in accordance with CLP SOW's and will be reviewed by both Radian